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**Investigation into the Barriers to Six Sigma in  
Libyan Manufacturing Companies and  
Development of a Framework for its  
Implementation**

**OSAMA . B . A . ELGADI**

A thesis submitted in partial fulfilment  
of the requirements of the  
University of Northumbria at Newcastle  
for the degree of  
Doctor of Philosophy

Research undertaken in the  
Mechanical Engineering Department

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## **Abstract**

The six sigma technique has been in use over the past decades, as a tool for quality improvement. It was first introduced by Motorola in the 1980s. However, this unique technique only became well known after GE's Jack Welch made it a central focus of his business strategy in 1995. Since then, thousands of companies around the world have adopted six sigma as a way of doing business. Today, six sigma is the fastest growing business management system. However, to date, there is no evidence of the adoption of six sigma in the Libyan manufacturing companies (LMCs). This research therefore aims to identify the reasons why six sigma has not yet been adopted in the LMCs and then to develop a framework for its implementation.

A comprehensive review of literature was carried out to identify the barriers affecting the implementation of six sigma that were experienced by different organisations around the world. The summarised barriers were subsequently used in the empirical investigation. The employed research methodology involved was a mixed-method approach, using a survey as the main strategy, starting by conducting interviews to collect qualitative data followed by the development of a questionnaire to obtain quantitative data.

The findings revealed that none of the LMCs have ever implemented six sigma, and also showed that there were six key reasons/ barriers behind their lack of six sigma use, which are: "Lack of six sigma training", "Lack of six sigma expertise and specialists", "Lack of knowledge and awareness about six sigma in our company", "Lack of top management commitment", "Culture effect", "We have not heard of six sigma, it is unknown to us".

Upon these findings, and with reviewing a wide and comprehensive literature of six sigma, a six sigma implementation framework was built for LMCs. The framework was carefully designed, developed and assessed. The proposed framework is clear and can be understood by all levels of managers and workers in a company. It offers guiding information on how six sigma implementation can begin by providing a valuable insight into the practice of six sigma. The framework serves as a platform which can enable manufacturing companies to identify the gaps in their implementation efforts, focus attention on areas for improvement and assess the potential benefits of six sigma. This will help LMCs to effectively implement six sigma and give them more capability to compete and opportunities to enter the global market. It will

also reflect a considerable impact on the national economy, and offer new job opportunities as well as opening new markets.

## **Declaration**

I declare that the work contained in this thesis has not been submitted for any other award and that it is all my own work. I also confirm that this work fully acknowledges opinions, ideas and contributions from the work of others.

I declare that the Word Count of this Thesis is 44,432 words

Name: Osama Elgadi

Signature:

Date:

## **Acknowledgement**

There is no doubt that without the help and continuous support that I received from many people and organizations; either directly or indirectly, this study could not have been conducted effectively or accomplished satisfactorily.

Thus, I would like to express my grateful appreciation to Dr. Martin Birkett, my principal supervisor, for his support, guidance, advice, time, energy and confidence he has given me, which has enabled me to achieve my work. I would also like to thank Dr. Wai Ming Cheung my second supervisor, for his suggestions to frame the research and his enthusiasm and patience.

I gratefully acknowledge the sponsorship of my country, Libya, despite experiencing political and civil unrest. I hope the knowledge I gained during my PhD journey would open the door for me to give back and serve my country. I should also acknowledge the support of all participants in the surveys, without their voluntary participation, this thesis would not have been possible.

Special thanks to my parents, brothers, sisters, my wife and children for their unlimited source of inspiration, encouragement and support since I started this journey.

Finally, I would like to thank the faculty of Engineering at Northumbria University, Newcastle, for their kind support throughout the period of my PhD. Thanks extends to the library staff and all the staff at the university of Northumbria for providing the extensive training, resources and support.

## Dedication

*I dedicate this work to my father, mother  
And all my family for their love and support:  
Wonderful brothers and sisters;  
Dearest wife;  
And my beloved children  
Sanad, Mayar, and Owais*

## Table of contents

Abstract.....	I
Declaration.....	II
Acknowledgement .....	III
Dedication .....	IV
Table of contents.....	V
List of tables.....	IX
List of figures.....	X
List of abbreviations .....	XII
<b>Chapter One .....</b>	<b>1</b>
1 Introduction.....	1
1.0 Chapter introduction .....	1
1.1 Background of quality management in Libya.....	1
1.2 Background & concept of six sigma (6- $\sigma$ ).....	3
1.3 Problem statement.....	7
1.4 Research aim and objectives .....	9
1.5 Research justification.....	9
1.6 Research layout.....	10
1.6.1 Introduction.....	12
1.6.2 Literature review .....	12
1.6.3 Methodology .....	12
1.6.4 Data collection .....	12
1.6.5 Data analysis and findings .....	12
1.6.6 Framework development.....	13
1.6.7 Framework assessment .....	13
1.6.8 Conclusion and recommendations .....	13
1.7 Original contributions to knowledge.....	13
<b>Chapter Two.....</b>	<b>14</b>

2	Literature Review.....	14
2.0	Introduction.....	14
2.1	Six sigma literature review .....	14
2.1.1	The history of six sigma.....	14
2.1.2	What is six sigma:-.....	15
2.1.3	Six sigma success and benefits .....	17
2.1.4	Six sigma success factors .....	17
2.1.5	Reasons for not implementing six sigma and barriers to its implementation .....	18
2.1.6	Six sigma framework .....	19
2.2	An overview of the Libyan manufacturing environment.....	22
2.2.1	Introduction.....	22
2.2.2	Geographical background .....	23
2.2.3	Libyan society and cultural aspects.....	24
2.2.4	Libyan economy.....	25
2.2.5	Libyan organizations management system .....	27
2.2.6	Libyan manufacturing industry .....	28
	<b>Chapter Three .....</b>	<b>34</b>
3	Research Methodology .....	34
3.0	Introduction.....	34
3.1	Definition of research methodology .....	34
3.2	Research philosophy .....	35
3.3	Research approach .....	38
3.4	Research strategy .....	40
3.5	Time horizons .....	42
3.6	Chapter summary .....	43
	<b>Chapter Four .....</b>	<b>44</b>
4	Data Collection .....	44
4.0	Introduction.....	44
4.1	Sources of data.....	44
4.1.1	Secondary sources of data.....	44
4.1.2	Primary sources of data.....	45
4.2	Data collection methods.....	45
4.3	Interviews.....	47



4.3.1	Types of interviews .....	47
4.3.2	Selection of interview technique .....	50
4.3.3	Generation of interview questions .....	50
4.3.4	Pre-testing and piloting the interview questions .....	53
4.3.5	Conducting the main interview .....	53
4.3.6	Interview data analysis.....	55
4.3.7	Interview findings summary .....	62
4.4	Development of the questionnaire .....	63
4.4.1	Questionnaire design.....	64
4.4.2	Question type and development .....	65
4.4.3	Questionnaire sections .....	67
4.4.4	Questionnaire scales.....	68
4.4.5	Translating the questionnaire .....	68
4.4.6	Pilot study .....	69
4.4.7	Reliability and validity of the questionnaire in the pilot Study.....	71
4.4.8	Population and sample .....	74
4.4.9	Questionnaire distribution and collection .....	74
4.4.10	Response rate in the final study .....	75
4.4.11	Reliability of the questionnaire in the final study .....	75
4.4.12	Data analysis techniques .....	75
<b>Chapter Five</b> .....		<b>79</b>
<b>5</b>	<b>Data analysis and findings .....</b>	<b>79</b>
5.0	Introduction.....	79
5.1	General information .....	80
5.1.1	Respondents' age .....	80
5.1.2	Respondents' position (job title) in the company .....	81
5.1.3	Respondents' educational level.....	81
5.1.4	Respondents' experience.....	82
5.1.5	Number of employees in the company (company size) .....	83
5.1.6	Type of ownership of the company.....	83
5.1.7	Company's type of industry .....	84
5.2	Quality management and six sigma background .....	85
5.2.1	Current quality systems in the company .....	85
5.2.2	Previously implemented quality systems in the companies .....	86

5.2.3	Quality training in the company.....	87
5.2.4	Interest in six sigma training .....	89
5.2.5	Interest in six sigma implementation .....	90
5.2.6	Decision maker to introducing six sigma to a company .....	90
	Figure 5.15: Decision maker to introducing six sigma to a company.....	91
5.3	Reasons/ Barriers for not implementing six sigma in LMCs .....	91
5.3.1	Test of significant differences.....	95
5.4	Influencing factors .....	106
5.4.1	Top management commitment.....	106
5.4.2	Training courses.....	108
5.4.3	Lack of knowledge and awareness about six sigma.....	109
5.4.4	Culture effect (resistance to change).....	111
5.4.5	Correlation analysis.....	113
5.5	Chapter summary .....	114
<b>Chapter Six</b>	.....	<b>116</b>
6	Development of the Implementation Framework .....	116
6.0	Introduction.....	116
6.1	Overcoming the barriers in LMCs .....	116
6.1.1	Creating a culture of change in LMCs .....	116
6.1.2	Top management commitment.....	118
6.1.3	Awareness of six sigma.....	118
6.1.4	Training programmes .....	118
6.1.5	Government support.....	119
6.2	Six sigma implementation framework .....	119
6.2.1	Definitions.....	120
6.2.2	The proposed framework .....	121
6.3	Validity assessment of the framework .....	138
6.3.1	Previously validated frameworks.....	139
6.3.2	Panel of experts.....	139
6.3.3	An assessment by potential users.....	140
<b>Chapter Seven</b>	.....	<b>141</b>
7	Conclusion and Recommendations.....	141
7.0	Introduction.....	141

7.1	Meeting the aim and objectives .....	142
7.2	Contribution to knowledge.....	144
7.3	Conclusion of the study.....	144
7.4	Limitations of the study .....	146
7.5	Recommendations.....	147
7.5.1	Practical recommendations .....	147
7.5.2	Recommendations for future work.....	148
<b>References.....</b>		<b>149</b>
<b>Appendices.....</b>		<b>157</b>
Appendix 1: Interview covering letter .....		157
Appendix 2: Interview covering letter (Arabic version).....		158
Appendix 3: Interview questions .....		159
Appendix 4: Pilot study covering letter (stage 1) .....		163
Appendix 5: Pilot study covering letter (stage 2) .....		164
Appendix 6: Research questionnaire in the pilot study stage 1 .....		165
Appendix 7: Research questionnaire in the pilot study stage 2 .....		172
Appendix 8: Research questionnaire in the pilot study stage 2 (Arabic version) .....		179
Appendix 9: Research questionnaire in the final study.....		186
Appendix 10: Research questionnaire in the final study (Arabic version) .....		193
Appendix 11: Supervisor's support letter .....		200
Appendix 12: Research questionnaire covering letter .....		201
Appendix 13: Framework assessment covering letter .....		202
Appendix 14: Framework acceptance form .....		203
 <b>List of tables</b>		
Table 3.1: Features of positivistic and phenomenological philosophies. ....		37
Table 3.2: Differences between deductive and inductive approaches .....		39
Table 3.3: Relevant situations for different research strategies. ....		40
Table 4.1: Interview questions and their sources .....		51
Table 4.2: Reasons and barriers behind the lack of six sigma use in LMCs .....		56
Table 4.3: Factors that could enable the adoption of six sigma in LMCs (Enablers).....		60
Table 4.4: Cronbach's alpha of each Section in the Questionnaire in the Pilot Study .....		73
Table 4.5: Cronbach's alpha of each Section in the Questionnaire in the final Study .....		75
Table 5.1: Distribution of age against position.....		80

Table 5.2: Distribution of number of employees against ownership .....	84
Table 5.3: Reasons/ Barriers for not implementing six sigma in LMCs .....	91
Table 5.4: Test of significant differences between the companies for six sigma barriers across categories of age .....	96
Table 5.5: Test of significant differences between the companies for six sigma barriers across all categories of position .....	96
Table 5.6: Pairwise comparison of position.....	97
Table 5.7: Test of significant differences between the companies for six sigma barriers across all categories of education .....	99
Table 5.8: Test of significant differences between the companies for six sigma barriers across all categories of experience.....	99
Table 5.9: Pairwise comparison of experience .....	100
Table 5.10: Test of significant differences between the companies for six sigma barriers across all categories of company size .....	102
Table 5.11: Test of significant differences between the companies for six sigma barriers across all categories of ownership .....	102
Table 5.12: Pairwise comparison of ownership.....	103
Table 5.13: Test of significant differences between the companies for six sigma barriers across all categories of company operation .....	104
Table 5.14: Factors influencing top management commitment.....	106
Table 5.15: Factors influencing training courses .....	108
Table 5.16: Factors influencing lack of knowledge and awareness about six sigma .....	109
Table 5.17: Factors influencing resistance to change .....	111
Table 5.18: Correlations between six sigma barriers.....	113
Table 6.1: DAMIC phases and activities .....	132

## List of figures

Figure 1.1: Total ISO certified companies in the UK and Libya 1993-2012 [2].....	2
Figure 1.2: ISO certified industrial companies in the UK and Libya 1993-2012 [2] .....	3
Figure 1.3: Research flow chart .....	11
Figure 2.1: Map of Libya .....	24

Figure 2.2: A comparison between the actual and targeted production level of the manufacturing industries for the period (2003-2007).....	30
Figure 2.3: Contribution of the subsections industries .....	31
Figure 3.1: The research onion. [65].....	35
Figure 3.2: Research methodology selected .....	43
Figure 4.1: Prototypical versions of the main mixed methods .....	46
Figure 4.2 Skewness and Kurtosis (Red curve shows the normal distribution) .....	78
Figure 4.3: Values of correlation coefficient ( $r$ ).....	79
Figure 5.1: Distribution of respondents' age .....	80
Figure 5.2: Distribution of respondents' position .....	81
Figure 5.3: Distribution of respondents' educational level.....	82
Figure 5.4: Respondents' experience .....	82
Figure 5.5: Company's number of employees.....	83
Figure 5.6: Company type of ownership.....	84
Figure 5.7: Company's type of industry .....	85
Figure 5.8: Current quality systems in the companies .....	86
Figure 5.9: Companies that had previously implemented a quality system .....	86
Figure 5.10: Type of quality system previously implemented .....	87
Figure 5.11: Company runs quality training.....	88
Figure 5.12: Type of quality training .....	89
Figure 5.13: Respondent's interest in six sigma training.....	89
Figure 5.14: Respondent's interest in six sigma implementation.....	90
Figure 5.15: Decision maker to introducing six sigma to a company .....	91
Figure 5.16: Distribution of factors around the Mean average score 3 .....	93
Figure 5.17: Pairwise comparison of position .....	98
Figure 5.18: Pairwise comparisons of experience .....	101
Figure 5.19: Pairwise comparisons of ownership .....	104
Figure 5.20: Factors influencing top management commitment .....	107
Figure 5.21: Factors influencing training courses.....	109
Figure 5.22: Factors influencing lack of knowledge and awareness about six sigma .....	110
Figure 5.23: Factors influencing resistance to change.....	112
Figure 6.1: The proposed implementation framework for LMCs.....	122
Figure 6.2: Six sigma methodologies.....	130
Figure 6.3: DMAIC cycle .....	131

Figure 6.4: DMAIC path..... 135

Figure 6.5: Phase 2..... 136

## List of abbreviations

Abbreviation	Meaning
CI	Continuous improvement
CIID	the Centre for Industrial Information and Documentation
CQI	Continuous Quality Improvement
CSFs	Critical Success Factors
CTQ	Critical-To-Quality
DFSS	Design for Six Sigma
DIDES	Define-Initiate-Design-Execute-Sustain
DMADV	Define, Measure, Analyse, Design, and Verify
DMAIC	Define, Measure, Analyse, Improve, and Control
DNA	Deoxyribonucleic Acid
DPMO	Defects per Million Opportunities
EQA	European Quality Award
GDP	Gross Domestic Product
IDOV	Identify-Design-Optimise-Validate
IMF	International Monetary Fund
ISO	International Organisation for Standardisation
ISO 9001	Quality Management System of ISO
L.D	Libyan Dinar
LMCs	Libyan Manufacturing Companies
LNCSM	the Libyan National Centre for Standardisation and Metrology
MBNQA	Malcom Baldrige National Award
MTS	Medium Term Strategy
PDCA	Plan Do Check and Act
PhD	Doctor of Philosophy
PIB	Privatization and Investment Board
QFD	Quality Function Deployment
ROI	Return-On-Investment

SMEs	Small & Medium Enterprises
SPSS	the Statistical Package for the Social Sciences
TQI	Total Quality Improvement
TQM	Total Quality Management
UN	the United Nations
WTO	World Trade Organisation
6σ	Six sigma

# **Chapter One**

## **1 Introduction**

### **1.0 Chapter introduction**

In this chapter, the researcher presents the background of the study, and then proceeds to provide the problem statement, the aim and objectives. The chapter also introduces the research justification and methodology. The intended contribution that is to be made by this research and the thesis structure are also explained.

### **1.1 Background of quality management in Libya**

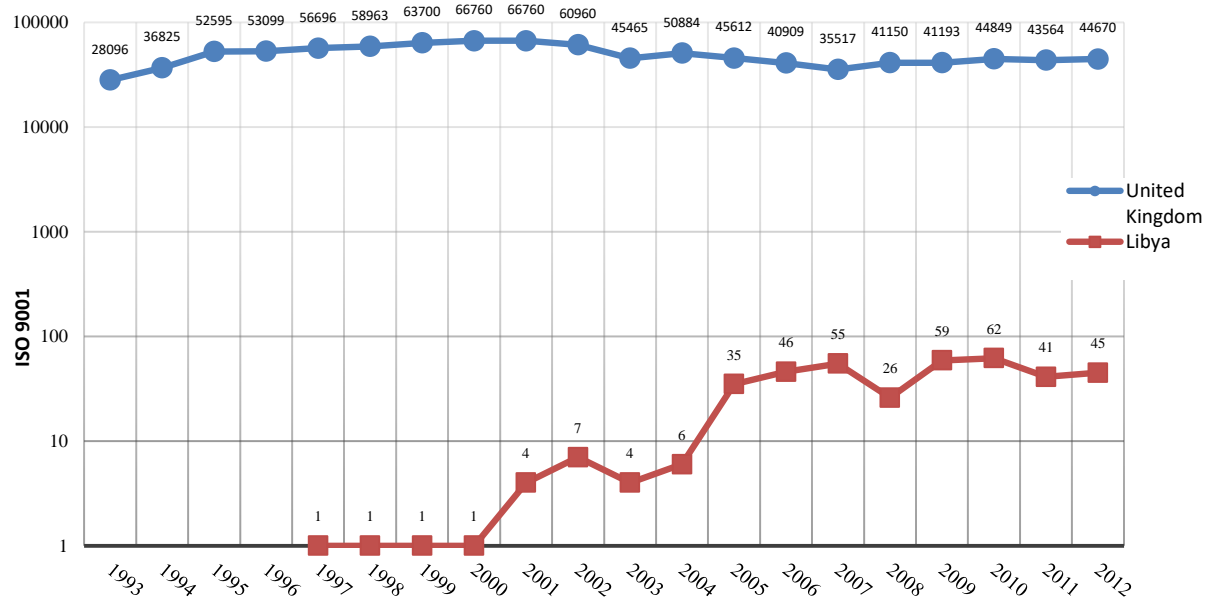
Within the last decade of the 20<sup>th</sup> century, Libya realized that the world has been rapidly changing. It is a world in which the international economy has moved from a geographical framework to a framework of virtual space. There are no political limits that can stand against these dynamic changes; these economic developments have at the present time, encouraged countries to move towards globalization where self-dependant economies are no longer feasible. This is exactly what is happening now in Libya, where serious steps have been taken by giving the highest priority to restructuring the Libyan economy. Through this process, Libya is also promoting local products to assist in diversifying economic activities, in order to help accelerate the process of Libya joining the World Trade Organisation (WTO). Towards this goal, Libya has recently approved a series of important laws dealing with foreign investors and companies as well as a series of resolutions being undertaken by the government [1].

These fundamental changes have caused Libyan organisations to move out gradually from under the government umbrella, which gave them a monopoly of products and services. In such a situation, Libyan organisations need to focus more on quality, as it is one of the crucial standards used to measure success levels. Libyan organisations have started to believe that it is vital to invest current resources into the use of quality improvement programmes, such as the adoption of the quality management systems of ISO 9000 and six sigma approaches [2].

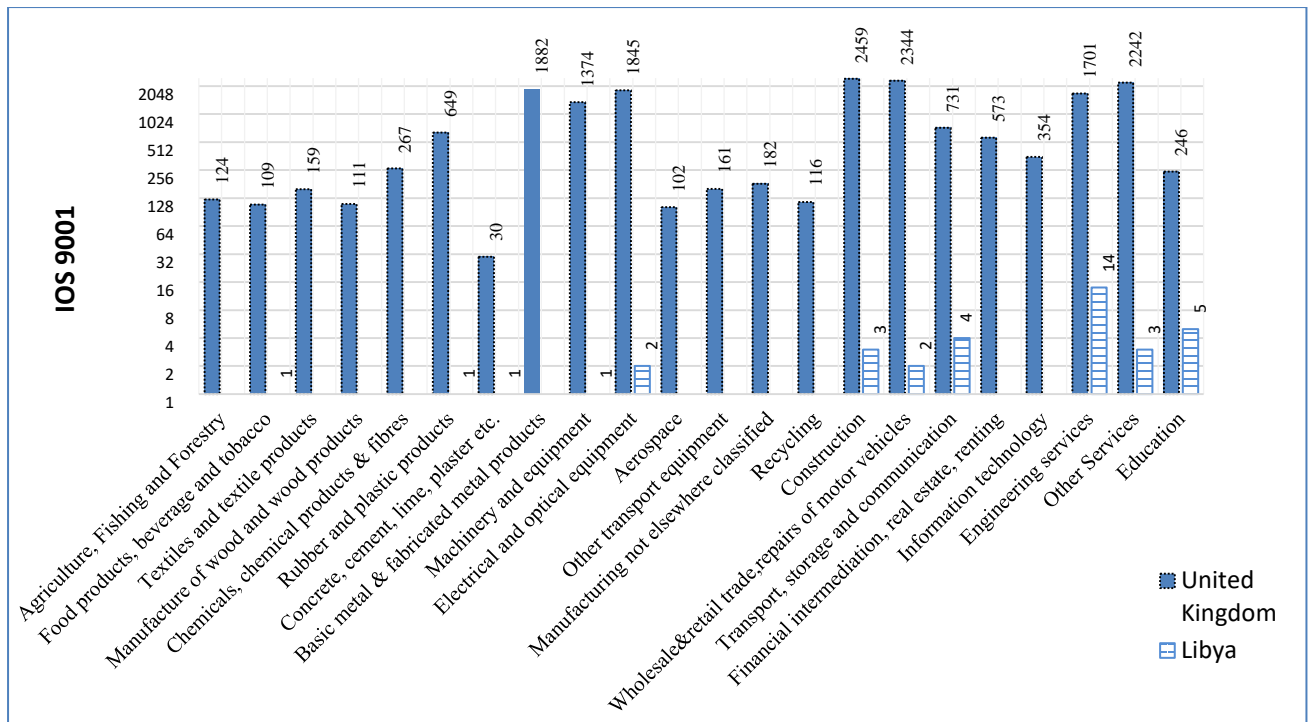


Quality management has a major contribution to product quality as well as other performance objectives such as productivity, cost and on time delivery. It is also capable of being applied as a competitive tool when linked to manufacturing strategy.

Since ISO 9000 was introduced in 1986, the number of organisations in developed and developing countries with ISO 9000 certification has been increasing dramatically. According to an ISO survey in 2012, the number of ISO 9001 certified organisations reached 1,1M around the world, of which 334,032 were in China and 44,670 were in the UK. Within the developing countries, the number reached 3,229 in the United Arab Emirates and 2,383 in Egypt. In Libya, however, this number up to the end of 2012 was still only 45, See figure 1.1. Moreover ,according to the ISO survey 2012, the number of certified UK industrial companies was 19,357 , whereas by comparison the number of certified Libyan industrial companies was only 37, See figure 1.2 [2].



**Figure 1.1: Total ISO certified companies in the UK and Libya 1993-2012 [2]**



**Figure 1.2: ISO certified industrial companies in the UK and Libya 1993-2012 [2]**

Another suggested technique that has been used over the past 30 years, as a tool for quality improvement is the six sigma approach. Data showed that corporate-wide six sigma deployments save an average of 2% of total revenue per year. The use of six sigma also saved fortune 500 companies an estimated \$427 billion [3].

These numbers help explain why six sigma adoption has increased phenomenally worldwide in recent years. It is proposed that these benefits of quality management and six sigma techniques could be transferred to the Libyan organisations, particularly those manufacturing companies that are growing at a very slow speed and face intense global competition. However, to this date to the best knowledge of the researcher there is no study that deals with the implementation of six sigma in the Libyan manufacturing companies. This research therefore aims to identify the reasons why six sigma has not yet been adopted in the Libyan manufacturing companies and more specifically, determine what the barriers to its successful implementation are

## 1.2 Background & concept of six sigma (6- $\sigma$ )

Six sigma (6- $\sigma$ ) is a set of techniques and tools for quality and processes improvement. It was first introduced in 1986 by Motorola, synchronizing with the Japanese assets price bubble, which is reflected in its terminology. Six sigma became well-known when Jack Welch made it central to his successful business strategy at General Electric in 1995. Currently, it is used

in several industrial sectors worldwide [4]. The word “Sigma”(σ) is a Greek letter used in statistics to measure how far a given process deviates from perfection [5].

Six sigma can be defined as an organized parallel-meso structure to minimize variability in an organizational process by using improvement experts, a structured method, and performance metrics with the goal of accomplishing strategic objectives [6]. Another definition describes six sigma as a data driven method to problem tackling, as a business process, as a disciplined statistical method, and as a management strategy [7]. It can also be defined as a process improvement methodology that seeks to enhance work performance through a firm and precise business focus. Six sigma is a systematic method to achieving continuous process improvements [8]. It is a comprehensive system for achieving, maintaining and enhancing business success.

Six sigma is considered the most important advancement in quality management and process improvement in the last two decades [6]. It aims to improve the quality of process outputs by identifying and eliminating the causes of flaws and reducing variability in manufacturing and business processes [9]. A set of quality management methods is used, including statistical methods, and builds a superior infrastructure of employees within the organization (Black Belts, Green Belts, and Yellow Belts) who are specialists in the methods. Each six sigma project applied within an organization follows a defined sequence of stages and has quantified value goals, for example: reduce process cycle time, reduce pollution, reduce costs, increase profits, increase customer satisfaction, and improve quality [10].

Six sigma is principally based on a detailed knowledge of customer demands and expectations, disciplined use of realities and objective data, statistical analysis and ongoing efforts focused on improving business processes. Six sigma involves the following key concepts [11]:-

- Critical to Quality: Attributes most significant to customers.
- Defect: Failing to deliver what customers desire.
- Process Capability: What your processes could deliver.
- Variation: What customer see and feel.
- Stable Operations: Ensuring consistent, predictable processes to improve what customers see and feel.

- Design for six sigma: Designing to meet customer demands and process capability.

The six sigma process uses two defined methodologies, DMAIC and DMADV. DMAIC is used to improve an existing process and involves five steps, Define, Measure, Analyse, Improve, and Control. These steps guide the improvement process and help detect the root causes of the failures in a single improvement project [8]. DMADV is used for a new process and involves five steps, Define, Measure, Analyse, Design, and Verify [5].

Six sigma can be discussed at three levels: - as a management system, as a methodology, and as a metric (a statistic). Any six sigma project uses management, methods and metrics at the same time [9]. At management level, six sigma is considered as a long series of approaches to improving virtually any process. It could be six sigma zero flaws, continuous quality improvement (CQI), and total quality improvement (TQI). All these terms propose a common goal improvement in a process or processes. Each six sigma project is supported by a team with defined duties and follows a defined sequence of stages and has quantified targets.

As a methodology, the subsequent points are considered as dynamic ingredients in achieving the statistical aim of six sigma:-

- Understanding and managing customer demands
- Aligning key business processes to accomplish those demands
- Utilizing strict data analysis to reduce variability in those processes
- Driving rapid and sustainable improvement to operation processes

Then, as a metric, is the source of the name six sigma. Six sigma refers to 3.4 defects per one million opportunities (DPMO). Six sigma started as a defect reduction effort (as in zero defects) in manufacturing and was then applied to other processes for the same purpose - quality improvement. When these three levels are properly introduced to a project they will lead to positive results of six sigma implementation [9].

Successful implementation of six sigma requires some activities and systems which can be summarized in the following points [12] :-

- Leadership: - The main role of leadership is to build a clear vision for six sigma successes, and to transfer that vision clearly, consistently, and frequently throughout the

organization. The principal responsibilities are to ensure that six sigma aims, objectives, and progress are well aligned with those of the enterprise as a whole.

- Infrastructure: - senior leaders use their acquired knowledge to direct the development and training of an infrastructure to manage and support six sigma.
- Communication and awareness: - steps are undertaken all together in order to “soft-wire” the organization and to develop a change-capable environment where creativity and innovation can prosper.
- Stakeholder feedback systems: - developing systems to establish reliable and close communication with customers, employees, and suppliers. This will include developing firm approaches of gaining and assessing customer, owner, employee, and supplier input.
- Process feedback systems: - developing a framework for continuous process improvement aligned with a system of indicators for observing progress and success.
- Project selection: - A six sigma project is implemented to improve work processes by people with experience at different levels of the organization. A six sigma project is decided based on established protocol, by top management, to achieve business performance objectives connected to measurable financial results.
- Project deployment: - six sigma projects are directed by project teams led by black belts or by green belts with technical support of black belts.

The successful implementation and deployment of six sigma will result in organizational success in terms of business improvement, customer satisfaction, and financial profits. The power of a six sigma technique is best described by proven return-on-investment (ROI) as shown below for Motorola, AlliedSignal, and General Electric (GE) [13].

### **Motorola ROI**

#### **1987-1994**

- ✓ Reduced in-process defect levels by a factor of 200.
- ✓ Reduced manufacturing costs by \$1.4 billion.
- ✓ Increased employee production on a dollar basis by 126%
- ✓ Increased stockholders share value fourfold.

### **AlliedSignal ROI**

#### **1992-1996**

- ✓ \$1.4 Billion cost reduction.

- ✓ 14% growth per quarter.
- ✓ 520% price/share growth.
- ✓ Reduced new product introduction time by 16%.
- ✓ 24% bill/cycle reduction.

## **General Electric ROI**

### **1995-1998**

- ✓ Companywide savings of over \$1 Billion.
- ✓ Estimated annual savings to be \$6.6 Billion.

Hence, the six sigma concept gains more and more importance due to its successful implementation in many manufacturing and services organizations. Approaches are therefore to be found in order to implement six sigma in developing countries such as Libya. This research will focus on identifying the reasons and barriers behind the lack of six sigma in Libyan manufacturing companies and then develop an implementation framework of six sigma. This sector is very significant in the country's future economy growth and total income diversification and also it is important to our everyday life.

### **1.3 Problem statement**

Libya, as many other developing countries faces internal and external pressure to improve its manufacturing systems to satisfy local customers and to promote the export of its production to developed countries that impose strict quality standards on imported products, with emphasis on consumer protection. However, at present the Libyan manufacturing companies are unable to improve their manufacturing systems to keep pace with the developed world, due to the lack of knowledge and implementation of advancing technological concepts in the world of quality management and six sigma. It is argued that this is not the only reason behind the backwardness of the Libyan manufacturing companies. There are several reasons such as:-

- Lack of awareness and poor knowledge of quality management and six sigma
- Absence of performance measures
- Incomplete and poor local standards which are frequently incompatible with the international standards
- Inadequate technical infrastructure

- Lack of government initiatives to promote manufacturing awareness and practices.
- Lack of training programmes

Therefore, Libyan manufacturing companies should seek to improve their quality management by implementing different approaches of administrative and technological concepts, and one of the most implemented techniques is six sigma. Those companies that can successfully implement six sigma will gain substantial benefits that contribute to competitive advantage and to changing culture from one of reactive problem solving to proactive problem prevention. Specifically the proven potential benefits of six sigma include [14]:-

For the organisation

- ✓ Bottom line cost savings (5%-20% of turnover per annum)
- ✓ Improved quality of products or services as perceived by the customer (internal and external customers)
- ✓ Reduction in process cycle times
- ✓ Development of staff skills
- ✓ Common language throughout the organisation
- ✓ World class standard

For the individual

- ✓ Improved knowledge and skills
- ✓ Ability to use a wide range of tools and techniques
- ✓ A status that is recognised world-wide such as (yellow belt, green belt, and black belt)

In theory, these benefits of six sigma could be transferred to Libyan manufacturing companies, in order to survive from the threat of the intense internal and global competition. However, *to date as there is no evidence of the adoption of six sigma in the Libyan manufacturing industry*. Hence, Libyan manufacturing companies must have encountered some barriers that have prevented this technique from already being implemented. Therefore, the researcher has been motivated to tackle this problem by identifying the reasons and the barriers behind the lack of six sigma in the Libyan manufacturing companies.

## **1.4 Research aim and objectives**

The aim of this research is to identify and investigate the reasons and barriers behind the lack of use of six sigma in Libyan manufacturing companies, and the critical factors affecting its successful implementation. Then using these findings to develop an implementation framework of six sigma for use in Libyan manufacturing companies.

### ***Research objectives***

- 1- Review the six sigma approach in order to understand its positive points and therefore the possibility of benefiting from it.
- 2- Review the relevant literature covering the area of six sigma with emphasis on the barriers and reasons that impede its adoption as well as the critical factors affecting its successful implementation in manufacturing companies.
- 3- Review of the Libyan manufacturing companies and their environmental work.
- 4- Develop an interview to be conducted in Libyan manufacturing companies to find out the reasons and barriers behind the lack of six sigma and use these findings to help in designing the questionnaire questions.
- 5- Develop a questionnaire and distribute it in the Libyan manufacturing companies to identify the reasons and barriers behind the lack of six sigma in this sector.
- 6- Analyse, investigate and interpret the data collected from the interview, questionnaire, and the literature review to develop an implementation framework of six sigma and recommendations to help the Libyan manufacturing companies to adopt six sigma as a solution to promote the level of manufacturing engineering and to keep pace with the global development in this area.
- 7- Recommendations and future work will be considered based upon a critical evaluation of the developed framework, and the results from the research.

## **1.5 Research justification**

In today's dynamic environment, there is a strong need for companies to become globally competitive, which pushes them to find a management system that facilitates continuous improvement of every aspect of their business operation. The increased awareness of senior executives, who have recognised that quality management is a significant strategic matter, is seen as a focus for all levels of the company.

Given the importance of the Libyan manufacturing companies on daily life, and its considerable impact on the national economy, we must give it great emphasis and diagnose



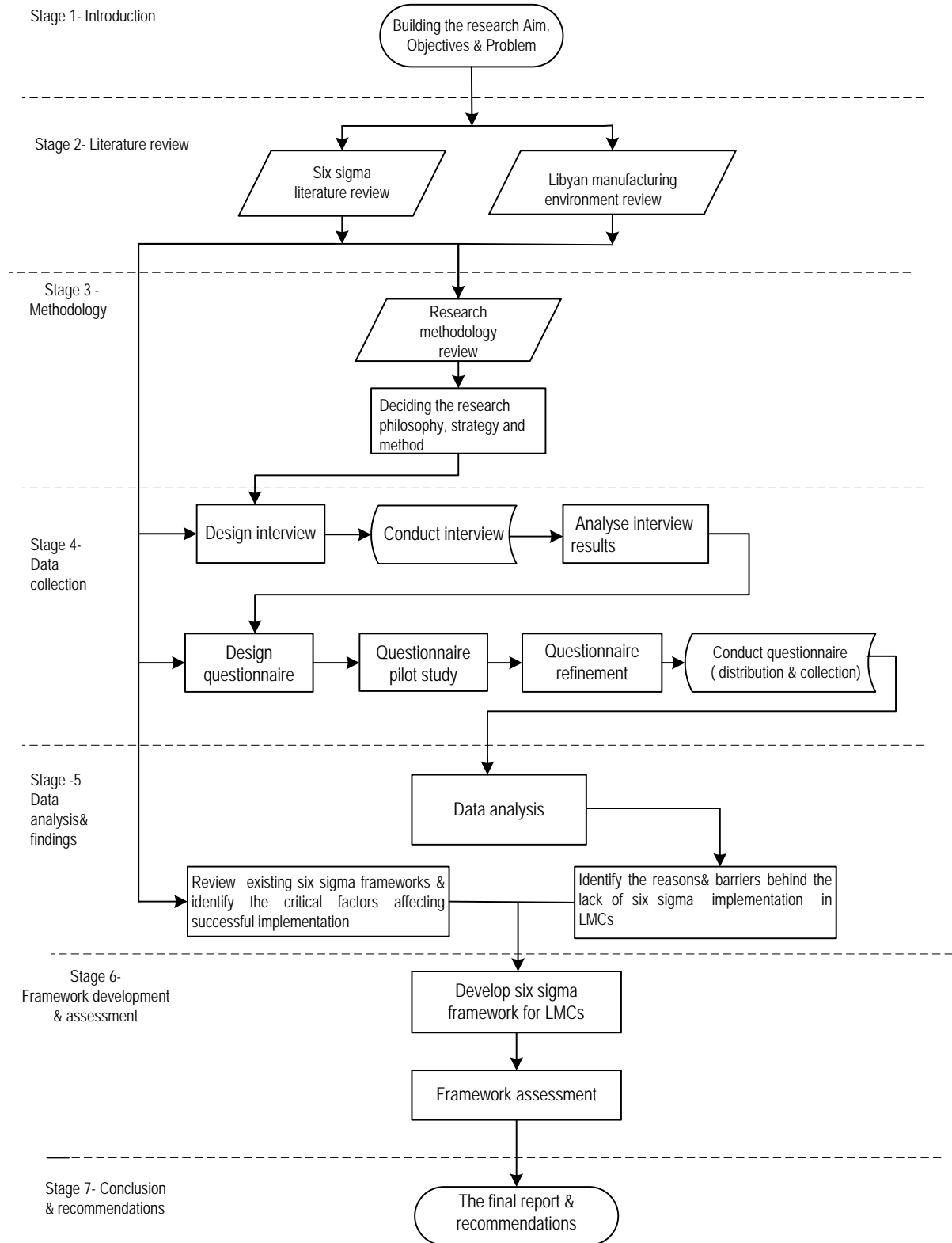
the problems and difficulties encountered within it, in order to promote and improve its performance and quality. To reach that goal, we must remedy the problems suffered by manufacturing, most of which is the fact that manufacturing in Libya did not take the appropriate steps to adopt a high level of quality system, and did not keep pace with the global development in this area.

Thus, the rapid development of many administrative and technological concepts, led to encouraging the servicing and manufacturing enterprises to search for proper method, ways and strategies of achieving their purposes and enhancing the services and products they provide with the available resources and potential. One of the initiatives that has become widely recommended and increasingly applied is six sigma techniques. The six sigma method is considered among the most recent methods in the astonishing improvement of the quality of services, products, and operations worldwide.

Based upon this, and due to the importance of the manufacturing sector, as well as the new direction of the Libyan economy and the lack of empirical research undertaken on this subject in Libya, research is needed to investigate the reasons and barriers behind the lack of six sigma in the Libyan manufacturing companies, and the critical factors that affect its successful implementation. From this, an implementation framework and recommendations would be developed, constructed and generalised, to help the Libyan manufacturing companies to effectively implement six sigma and give them more capability to compete and opportunities to enter the global market.

## **1.6 Research layout**

This research will be conducted by undertaking the stages shown in figure 1.3.



**Figure 1.3: Research flow chart**

### **1.6.1 Introduction**

In this stage, the researcher presents the background to the study, and then proceeds to provide the problem statement, the aim and objectives. This stage also introduces the research justification and methodology. The intended contribution that is to be made by this research and the thesis structure are also explained.

### **1.6.2 Literature review**

The relevant literature to the six sigma technique are reviewed, followed by a theoretical review of critical success factors related to the successful implementation of six sigma in the manufacturing sector. This preliminary review will help the researcher to understand six sigma and its implications to build a firm base for this area of research. The literature review will also include an overview of the Libyan manufacturing environment. Six sigma training courses will also be undertaken to enhance and extend the researcher's practical knowledge of the subject.

### **1.6.3 Methodology**

This stage describes the detailed research methodology that will be utilized to meet the objectives and the aim of the research. It concentrates on methodology issues, justifies the choice of the research method and illustrates the rationale behind the choices made.

### **1.6.4 Data collection**

In this stage, Libyan manufacturing sector data will be collected from various sources, which are considered reliable, using different approaches and techniques. Firstly, regarding to the secondary data, the official Libyan information and documentation centres, textbooks, journal articles, conference papers, census data, government annual reports, and some previous studies will be used. Then, as a survey is chosen as a main strategy for this research, interview, and questionnaire will be used to collect the main primary data set.

### **1.6.5 Data analysis and findings**

In this stage, the data and results collected from the previous stages will be analysed and interpreted with the help of SPSS software in order to develop a framework and recommendations of six sigma to be presented to the Libyan manufacturing companies as a methodology to guide them into the right direction towards six sigma implementation.

### **1.6.6 Framework development**

In this stage, a framework of six sigma will be developed based on the literature review and the collected data, which is designed to suit the Libyan manufacturing companies.

### **1.6.7 Framework assessment**

The developed framework will be assessed using a combination of reviews by six sigma experts and potential users of the framework in Libya.

### **1.6.8 Conclusion and recommendations**

In this stage, the researcher will summarise the main findings from the research and give recommendations to be presented to Libyan manufacturing companies as a methodology to guide them towards six sigma implementation. A number of extra recommendations and suggested directions for future work will also be presented.

## **1.7 Original contributions to knowledge**

This research will provide a contribution to the existing knowledge as following: -

- Due to the lack of research on six sigma implementation in the Libyan manufacturing sector, this research is, to the best knowledge of the researcher, the leading study in the area of six sigma in the Libyan manufacturing sector; consequently its findings and outcomes are an original contribution to existing knowledge.
- This research identifies the factors behind the lack of six sigma in the Libyan manufacturing sector, as a result its findings and outcomes are of great value to Libyan manufacturing companies that are interested in adopting six sigma, in terms of providing them with guideline methodology, and effective recommendations for its successful implementation. This will also form a valued database to the Libyan government principally to the ministry of industry.
- The results and outcomes of this research contribute to knowledge by offering new suggested directions for further work to extend the literature of six sigma, and more specifically provide data analysis, which assesses the implementation of six sigma in the Libyan manufacturing sector.

# Chapter Two

## 2 Literature Review

### 2.0 Introduction

The purpose of the literature review is to identify and understand the concepts, principles, theories, and knowledge on the subject under investigation. Thus, this chapter reviews the literature on various aspects of the six sigma technique and gives an overview of the Libyan manufacturing environment

### 2.1 Six sigma literature review

#### 2.1.1 The history of six sigma

There are many discrepancies in the literature as to when and where the six sigma programme was actually started. Various authors claim that the six sigma quality initiative was started in different times like in the mid -1960s, the later part of the 1970s, in the earlier part of the 1980s, in 1986 and in 1987 [15]. However from this the authors concluded that a large portion of the researchers and practitioners believe and affirm that six sigma originated at Motorola by Bill Smith in 1986 and was officially launched in 1987, which enabled Motorola to win the most coveted Malcom Baldrige National Award (MBNQA) in 1988, then six sigma became a federally registered trademark of Motorola [15].

Motorola engineers decided that the traditional quality levels, which measured defects in thousands of opportunities – did not provide enough granularity. Instead, they wanted to measure the defects per million opportunities. Motorola developed this new standard and created the methodology and required cultural change associated with it. Six sigma helped Motorola realize powerful bottom-line results in their organization – in fact, they documented more than \$16 billion in savings as a result of their six sigma efforts. Since then, hundreds of companies around the world have adopted six sigma as a way of doing business [16].

### 2.1.2 What is six sigma:-

Understanding six sigma first requires providing a conceptual definition and concepts of it. In 1986, Bill Smith, a reliability engineer and scientist at Motorola's communication division, coined the word 'six sigma' and presented his ideas to Robert Bob Galvin, the chairman of Motorola. He proposed six steps to six sigma for process improvement and 'Mechanical Design Tolerancing' for the reduction of defects to 3.4 Defects per Million Opportunities (DPMO). Galvin was impressed by the name six sigma because it sounded like a new Japanese car and he needed something new to attract attention. Galvin committed himself to the name, the concept, and approved it [15].

Sigma,  $\sigma$ , is a Greek letter used in statistics to measure the variability in any process. Six sigma has been defined in the literature in a variety of ways, which can be categorised into three divisions, namely, 'statistics -based', 'management-oriented' and both 'statistics –based and management-oriented'[15]. As statistics-based six sigma has been defined as a statistical measure of the performance of a process or product. It is used as a quality control mechanism, which seeks to reduce defects or variations in a process to 3.4 defects per million opportunities thereby optimizing output and increasing customer satisfaction [17]. When defined as a statistically-based quality improvement programme, it helps to improve business processes by reducing waste and costs resulting from poor quality and improving the levels of efficiency and effectiveness of the processes [18]. Statistically, six sigma refers to a process in which the range between the mean of a process quality measurement and the nearest specification limit is at least six times the standard deviation of the process. The statistical objectives of Six sigma are to centre the process on the target and reduce process variation [19]. Six sigma has been defined as a management-oriented, business improvement strategy that seeks to find and eliminate causes of defects or mistakes in a business process by focusing on outputs that are of critical importance to customers. It is a powerful approach to process improvement, the reduction of costs and the increase of business profitability and revenue growth [20].

And then as both statistics-based and management-oriented, six sigma can be defined as a business process that allows companies to drastically improve their bottom line by designing and monitoring everyday business activities in ways that minimize waste and resources while increasing customer satisfaction. Further it is described as an improvement programme for reducing variation, which focuses on continuous and breakthrough improvements, in a wide

range of areas and at different levels of complexity [21]. It is also defined as a rigorous, focused, and highly effective implementation of proven quality principles and techniques. Incorporating elements from the work of many quality pioneers, six sigma aims for virtually error-free business performance [12].

After a careful analysis of the various definitions Prabhushankar [15] made a holistic definition of six sigma:- Six sigma can be defined as a highly disciplined, systematic proactive, powerful and multifaceted

problem solving or continuous and/or breakthrough business/process improvement strategy, which seeks to find and eliminate the sources of error or the causes of customer-defined mistakes or defects, drive out wastes in business processes, and reduce variation, and improve the efficiency and effectiveness of organisational operations, and strives to reach a level of 3.4 DPMO using extremely rigorous data gathering and statistical analysis, thereby meeting or even exceeding customers' needs and expectations with a focus on financially measurable bottom-line results [15].

The six sigma technique has been developed to improve quality, reduce cost and improve responsiveness, and more than 69 quality-related initiatives have come into existence in the later half of 20<sup>th</sup> century [21]. Six sigma is one of the latest among them which helped many of the big US corporations save billions of dollars, therefore it is considered the most successful business improvement strategy in the last 50 years. Its relevance extends beyond manufacturing to services, government, public sector, and healthcare [22]. Although the tools that are used in six sigma are similar to most contemporary quality programmes, the six sigma methodology is considered different from other continuous improvement programmes such as total quality management (TQM) and kaizen [23]. Six sigma differs from other quality programmes in its 'top-down' drive in its rigorous methodology that demands detailed analysis, fact-based decisions, and a control plan to ensure ongoing quality control of a process. Six sigma is a long-term commitment, and will not work well without full commitment from upper management. Six sigma changes the way a company thinks by teaching fact-based decision making to all levels. The programme changes the 'DNA' of a company by changing the way the leaders think and by improving the management pipeline by developing management and communication skills in people [19]. Therefore six sigma has been characterized as one of the advanced management fad to repackage old quality management principles, practices, tools, and techniques [24].

### **2.1.3 Six sigma success and benefits**

Six sigma techniques has been perhaps the most successful business improvement strategy in the last a few decades. The application of six sigma goes beyond manufacturing to services, healthcare, public sectors and government [15]. A “big dollar impact” cited by Hoerl [25] as one of key reasons for the success of six sigma implementation, this is not the only reason behind implementing it, however there are some other reasons for the benefits of six sigma implementation [26] :-

- ✓ Reduction of defects
- ✓ Reduction of cycle time
- ✓ Reduction of delivery time
- ✓ Reduction of process variability
- ✓ Reduction of customer complaints
- ✓ Reduction of costs
- ✓ Reduction of checking/ inspection
- ✓ Productivity increase
- ✓ Sales increase
- ✓ Profit increase
- ✓ Improved attitude of top management and employees towards quality and problem solving
- ✓ Improved employees' morale.

These benefits justify why to adopt six sigma. In theory, these benefits of six sigma could be transferred to Libyan manufacturing companies, in order to survive the intense internal and global competition.

### **2.1.4 Six sigma success factors**

The success of six sigma depends on “Critical Success Factors” (CSFs). The CSFs are those factors that are critical to the success of a company. In the sense that if objectives linked with the factors are not achieved the company will fail. The reason behind finding CSFs as a base for determining the information needs of managers was promoted by Rockart [27]. Henderson and Evans [28], performed a study and suggested top management support/involvement, organisational infrastructure, training, statistical tools, human resource (promotion, bonuses), early communication to employees, measurement system, an



information technology as the major components for successful implementation of six sigma.

Coronado and Antony [29] identified the key elements for an efficient and effective six sigma implementation, based on a review of existing literature, these elements are: top management commitment and involvement, cultural change, organisation infrastructure, training, project management skills, project prioritisation and selection, reviews and tracking, understanding the six sigma methodology, tools and techniques, linking six sigma to business strategy, linking six sigma to the customer, linking six sigma to the human resources, and linking six sigma to the supplier.

From the above literature review, CSFs of six sigma can be identified as:-

- Top management support/involvement/ commitment
- Appropriate organisational infrastructure
- Adjustment to cultural change
- Suitable education and training
- Effective use of six sigma methodology and tools
- Human resource (rewards, recognition)
- Employees involvement and empowerment
- Active project management skills
- Linking six sigma to the customer

#### **2.1.5 Reasons for not implementing six sigma and barriers to its implementation**

In spite of its reputation as a powerful quality technique, six sigma has faced and challenged some obstacles and barriers, Antony et al. [30] stated some reasons for not implementing six sigma as seen by their study respondents such as “not aware of six sigma, insufficient resources, existing quality systems is sufficient, not required by customers, and no perceived benefits”. Another study by Kumar et al. [31] found that reasons for not implementing six sigma were “lack of knowledge of six sigma, not sure of its relevance, availability of resources, never heard of it, other competing initiatives, bureaucratic, and leadership desire. While Chakrabarty & Chuan [32] found in their study that the reasons and barriers for not implementing six sigma were “ unknown to us, not interested, not relevant, time consuming, too complex to use, difficulty in collecting data, and difficulty in identifying process parameters”. In addition to that, Raghunath & Jayathirtha [33] specified some barriers for six

sigma implementation by some organisations which were “lack of resources, lack of leadership from top management, lack of knowledge about six sigma, internal resistance, insufficient organisational alignment, poor training and coaching, wrong identification of the process parameters, poor six sigma project selection, too complex, and cultural barriers”. Kokkranikal et al. [34] stated that “organisational culture, lack of resources, resistance to change, lack of enthusiasm, and lack of time to work on six sigma project” were considered as reasons and/or barriers facing the implementation of six sigma by some organisations. Another study by Kundi [35] specified some problems faced in six sigma implementation, which were “lack of communication, lack of management commitment, lack of resources, insufficient training, poor data collection, measurement problems, lack of team culture, and organisational resistance”.

### **2.1.6 Six sigma framework**

A popular framework for implementing a six sigma methodology is the DMAIC process. DMAIC, or Define, Measure, Analyze, Improve and Control are the key processes of a standard framework for a six sigma project [36].

DMAIC is a methodology used for process improvement. In other words it is applied for existing products and processes when their performance is inadequate. The other methodology is DFSS, Design for Six Sigma, this methodology is used for design improvement, the most popular approach for this methodology is DMADV (Define-Measure- Analyse-Design- Verify) this methodology is applied for new products and processes [37, 38]. The selection of which methodology to use depends on whether the project is for process improvement or design improvement.

DMAIC is the most used and popular methodology for six sigma implementation, it offers a structured and disciplined process for solving business problems. Six sigma uses tools designed to identify root causes for the defects in processes that keep an organisation from providing its customers with the consistent quality of products they require on time and at the most reasonable cost [38]. More details about six sigma frameworks and methodologies will be presented in chapter 6.

#### **2.1.6.1 Review of empirical studies on six sigma and quality management implementation frameworks and models**

Kumar et al. [39] proposed a six sigma implementation framework that provides a roadmap to manage and sustain change. This research proposes a six sigma implementation

framework/ roadmap designed to the requirements of small to medium enterprises (SMEs) by carrying out analysis of quality management frameworks/models for SMEs and drawing outcomes from empirical research conducted over three years. The main emphasis of the research is to develop a tailored framework for six sigma implementation in SMEs. Triangulation methods including survey, multiple case studies and secondary research have been conducted for data collection. The primary and secondary research have been conducted to extract the results and joint to design the six sigma basis for SMEs. The authors established a six sigma execution framework consisting of five phases that includes; readiness for six sigma, prepare, initialize, institutionalize, and sustain. It has been recommended to conduct case studies in different organizations so that the real practical approach of the framework can be experimented and tested.

Jones et al. [36] introduced the basis for effective implementation of six sigma tools and practices. The researchers apply the Plan Do Check and Act (PDCA) cycle to operate six sigma implementation. They discourse the prominence of top management promise and the importance and working of black belts in processing of six sigma and connect its implementation with quality management and the PDCA cycle. The projected framework of six sigma implementation takes into consideration both methodological characteristics of six sigma and the organizational and contextual variables. The outcomes revealed that there is a need for the application of an organized methodology for six sigma implementation. Executive commitment variable is also a key for making its implementation effective. Black belts and the availability of financial resources are the keys for its successful implementation. They recommended that there is a need to operationalize the concepts proposed in their study and apply those using empirical data. It has also been advised that the implementation of six sigma in the environment of supply chain could improve the performance of supply chain projects.

Lee et al. [40] have developed a readiness self-assessment model for six sigma for Chinese enterprises. As six sigma is getting more renowned due to the development of organizations with immense improvements in both their processes and products. It works for reducing operative deviation with statistical tool sets. The main challenge for effective implementation of six sigma is its readiness, enthusiasm and willingness. This study aims to develop a self-assessment model to determine the willingness for Chinese enterprises to adopt the six sigma technique. An inclusive literature review for the sound background evidence was conducted

for six sigma development. Validation of the developed readiness model was conducted by a survey with a questionnaire and interview with the organization's top management and data was gathered and studied to identify the success of the model. Total surveys from the three companies were conducted and only one company passed the assessment test.

Hansson and Klefsjo [41] have created a core value model for TQM implementation, developed based on multiple case studies in nine manufacturing and services firms in Sweden. The core value-based model consists of three phases describing an overarching recommendation for how to implement TQM. Activities in combination with working with core values validate the researchers' conclusions from successful implementation processes in nine organisations compared and analysed with the theoretical base. The study also confirms the ideas by Hellsten and Klefsjo [42] that it is essential that suitable techniques and tools support the core values in order to establish a quality culture. The described theoretical frame of reference, together with the empirical findings, creates a knowledge foundation that facilitates the understanding TQM implementation.

Youssef [43] developed a total quality management framework for Libyan process and manufacturing industries. The main aim of this study was to identify the drivers and barriers to the implementation of TQM in the Libyan manufacturing industry and to develop a model through which Libyan companies could implement and maintain improved quality systems.

The TQM framework was developed and modified for use within Libyan manufacturing industries. The framework spreads a methodology to implementation incorporating top-down deployment and bottom-up participation. It provides guidelines for applying TQM in four phases and is designed to help Libyan companies get started and move step-by-step towards a TQM culture. Youssef said that moving from one phase to the next depends on utilising knowledge and experience gained during the previous phases and achieving each phase assessment criteria. The author stated that the implementation of this model would work faster and more efficiently if there was strong commitment from the top management and employees within the Libyan organisations.

However, there is a scarcity of research about six sigma implementation frameworks in developing countries such as Arabic and North Africa countries. Alsmadi et al. [44] carried out an empirical study on implementing six sigma in Saudi Arabia. The study focuses on six

sigma implementation among the fortune 100 manufacturing and service firms in Saudi Arabia, since they represent the most important organisations operating in the country and could serve as an indicator for the extent of six sigma adoption. The results indicate that the rate of six sigma implementation is about 32% of respondents. The main reason behind this relatively high level of six sigma implementation, is the popularity of six sigma compared with other similar initiatives. The barriers and impediments were, lack of top management and leadership, lack of knowledge about six sigma methodologies, lack of resources in terms of people, budget and time, insufficient education of the value of six sigma, poor project selection. The study also investigated six sigma implementation success factors, tools and techniques used, level of training, and benefits gained from implementation. Moreover, the findings suggest that there is no significant difference in the level of most of six sigma practices between manufacturing and service firms, which asserts that service firms recognise six sigma and are using it to boost their performance.

El Safty [45] carried out a study on critical success factors of six sigma implementation in the automotive industry in Egypt. The research aimed to investigate the process of six sigma implementation in order to identify the critical success factors.

His findings indicated that the belief among the respondents that management engagement, communication, training and monitoring progress are all critical success factors for six sigma implementation. Also, the findings confirm that there is no significant difference among different experience levels, functions, and automotive sectors in perceiving and evaluating the critical success factors of six sigma implementation in automotive industry in Egypt.

## **2.2 An overview of the Libyan manufacturing environment**

### **2.2.1 Introduction**

Many authors believe that differences in organizations around the world arise not only because of where the organizations are based, but also because of other influences such as natural resources, political systems, national culture, and economic policies [46]. As this research focuses on Libyan manufacturing companies, it is necessary to describe several aspects of the Libyan manufacturing environment, which have a tangible impact on people's attitude and behaviour. Employees' confidence, commitment and performance are very predictable on the basis of the environmental aspects [47]. In general, the country's environment affects the management and organisational behaviour and this will in turn affect

the enhancement of managerial approaches, particularly methods and management thinking. This overview will provide the reader a clear background and plenty of information on how the Libyan manufacturing environment may affect the adoption of six sigma process.

This subsection reviews the Libyan manufacturing environment aspects and provides information on the main features, changes, and issues. It outlines the geographical, cultural, economic aspects, which may affect the quality performance and efficiency of Libyan organizations. The subsection ends with an overview of the management system and manufacturing industry in Libya.

### **2.2.2 Geographical background**

Geographically, Libya is located in North Africa bordering the Mediterranean Sea to the North with a coastline of approximately two thousand kilometres. Libya is neighboured to the east by Egypt, to the southeast by Sudan, the south by Chad and Niger, and to the west by Tunisia and Algeria (see Figure 2.1 map of Libya). Libya is considered one of the biggest countries in Africa in terms of size having an area of 1,775,100 square kilometres, of which 90 % is desert or semi-desert. Libyan climate is affected by the Mediterranean Sea at the north coast and the desert for the rest of the country. Therefore, the weather in the northern parts of the country is usually hot and dry in the summer, rainy and warm in winter. Whereas is very hot and dry in the summer, cold and dry in winter in the desert parts of the country [48]. According to the 2010 bulletin of the Libyan Bureau of Statistics and Census [49], the population of Libya is approximately 6,000,000 with a growth rate of 1.78 % per year. Libya, in terms of population is considered one of the least densely populated countries in the world, the population density average around 3 persons per square kilometre. The highest populated cities are the capital Tripoli and Benghazi with populations of approximately 1,770,000 and 1,150,000 respectively, where the other cities have much smaller population density [1].



**Figure 2.1: Map of Libya**

Source: [www.google.co.uk](http://www.google.co.uk)

### 2.2.3 Libyan society and cultural aspects

Many authors believe that cultural differences have an effect on management matters, and they also believe that an organization's culture is a key to its success [50]. Aghila [47] found that the direct transfer of developed countries' theory to developing countries without considering the cultural differences, will face issues in implementing of organizational and management practices. Consequently, the researcher must undertake a critical review of the Libyan society and cultural aspects.

Libyan society basically consists of the extended family, clan, and tribe. The society is very affected by religious factors, Islam as a religion of the Libyan nation plays a very important role in connecting all aspects of life. Bait-Elmal.A [51] stated “ Islam for Libyan people, is a code that directs social relations from home to the market place to the work place. It is a philosophy for everyday life”. Libyan organizations' work culture differs somewhat from western culture, and is more or less similar to other Arabic countries. The Arabic culture has spread and dominants in Libyan communities, affecting both as individuals and group behaviour. The exchange of information, data, and communications between and within organizations are frequently informal [52]. On the other hand, Libyans tend to act and work within groups and businesses depend on friendships. In such environments, trust and

reliability are really significant factors. Due to the traditional harmony of families and groups, Libyans are able to think collaboratively and are equipped with a great level of social competitiveness, this allows the creation of teamwork in organizations and public administration easier [53]. Aghila [47] commented that employees within Libyan organizations build strong social relationships, and stated that “this type of organizational culture is carried through the society in which there are tight relationships of individuals in the family and tribe and these relationships are reflected in the organizations”.

As a consequence, organizations are managed by achieving individual obligations towards group members instead of organizational needs. These concepts therefore need to be modified in order to implement any new technology or system successfully. Because in a such environment it could be hard to introduce a new technology or system, a such culture it could have both negative and positive impact ,and it might be considered as a push factor and might also be considered as a barrier to the implementation of six sigma.

Hence, the cultural differences among nations and specifically between developing and developed nations need to be recognized, considered, and understood, this can help to avoid any problems or obstacles that could occur during the transfer of any new technology or technique such as six sigma from one country to another. Therefore top management need to be highly involved in creating and performing the organization’s mission, vision, goals, and plans. Managers are responsible for eliminating resistance to change, and building quality as a culture throughout the organization, satisfying customer demands and expectations, and encouraging continuous improvement.

#### **2.2.4 Libyan economy**

Before the exploration of oil, the Libyan economy was based on agriculture and pasturage, in addition to that there were a number of small factories established to make light and traditional products such as fish and vegetable canning, olive oil refining, leather tanning, and processing domestic crops. However, after the discovery of oil in Libya in the 1960s, the Libyan economy started rising and the oil industry has since dominated the Libya’s total national income. Libya with its small population has one of the highest per capita GDPs in Africa, and it is regarded as one of the richest countries in the continent [50].



The oil and gas industry is considered the driving force of the Libyan economy, and accounts for about 96% of export earnings, 98 % of government revenues, and 65% of the country's Gross Domestic Product (GDP) [54].

The other industrial sectors in Libya including manufacturing account for a minor percentage of GDP, despite the efforts to create valued enterprises to replace the oil as a main resource in the future. The government gives priority to heavy manufacturing industry in its budget in many development plans, and in 1970-1990, the total budget allocated to heavy industries was \$1.7 billion [53]. This number reflects the insistence and aspiration of the government to diversify the economy and to develop the non-oil industries with the aim to achieve alternative sources and replace oil as a main source of the country's income. The non-oil industries comprise heavy and light industries such as cement, plastic, iron, tires, buses, trucks, tractors, chemicals, electronics, textiles, paper, food, and furniture. Diversification of the economy into manufacturing industries is still a long-term issue.

Due to the risk of relying too much on oil revenues, dangers of country's economy collapse have begun to appear, and therefore the Libyan government have had to implement a privatisation policy as most aspects of production and trade still under public control .The government also need to consider diversifying from its heavily oil dependent economy and encourage investments and growth in non-oil industries as these can form a significant part of the Libyan economy by creating new jobs, capital investment, and freeing the economy from reliance on oil. This would also contribute the gross national income and provide a better life for the current and future generations. This view was also supported by the IMF (International Monetary Fund) report No (06/137, 2006, p7), which stated that: -

*“Libya needs a comprehensive medium term strategy (MTS) to reform its economy and make better use of its economic and financial potentials, by diversifying the economy and reducing the country's dependency on oil. The proposed MTS aims at maintaining macroeconomic stability and rationalizing the use of the country's oil wealth, accelerating the transition to a market economy, and establishing a solid basis for the development of the non-oil economy”.*

The Libyan economy dependence on oil became sorely evident after the 17<sup>th</sup> of February revolution that overthrew the Qaddafi regime in 2011. The resultant conflicts disrupted oil

production and exports, causing a sharp fall in production from 1.7 million barrels a day in 2010 to less than 0.5 million barrels a day in 2011. This led to the entire collapse of the Libyan economy. GDP fell by 62 % and due to dependency on the oil sector, non-oil sector real GDP also declined by 52 %. Within one year, nominal GDP was less than halved from \$75 billion in 2010 to \$35 billion in 2011. However, the Libyan GDP rebounded dramatically and growth jumped to nearly 104 % in 2012 as oil production recovered much faster than predicted, reaching a near pre-revolution level of 1.4 million barrels a day. With non-oil GDP growing by 44%. But the recovery stalled in 2013, as the oil sector has been paralysed by prolonged strikes at key oil terminals and loading ports, removing more than 1 million barrels per day of crude oil production from exports [54].

In 2013 and 2014 the growth of the Libyan economy was negative and on the verge of short term collapse due to the sharp decline in oil production exports and prices. According to the estimates of the World Bank and the International Monetary Fund (IMF) indicate that during the year 2013, the GDP fell by 5-6% ,the main reason that it did not fall more was that, unlike in 2011, the government maintained its expenditure by spending international reserves held in the Central Bank of Libya, and also by using the foreign assets of the Libyan investment authority, which was not possible to use in 2011 due to the UN imposed freeze on Libyan foreign asset[54].

From above, it is obvious that the Libyan economy is heavily based on the oil sector, and therefore the Libyan government have to diversify the economy into other industries and activities rather than depending on solely oil. Libya today is at a turning point, both economically and politically, the imbalance of the Libyan economy cannot be addressed within the short term, and consequently, new plans, strategies, organizational systems and technologies are urgently required.

### **2.2.5 Libyan organizations management system**

The management system in Libyan organizations is similar to that in many other developing countries. Sharif.I [55] cited that the organizations' structure in developing countries is hierarchical, status-oriented and decisions are taken on the basis of non-rational criteria. He added that developing countries transferred contemporary management theory and techniques from developed countries in order to enhance their management systems based on the adoption of the experience of developed countries' models and systems. However, the

cultural and social aspects between developing and developed countries have not been taken into consideration and that created a wide gap due to the differences between the cultural values practiced in the developed and developing countries. Agnaia [56] commented that although time pressure is one of the factors most often faced by Arab managers, a study of Libyan organizations managers revealed that many Libyan managers are not punctual , they arrive late at work in the morning, leave before the official end of the working day ,and are frequently absent during the day. The study has also shown that little attention is paid to the significance of time during the official working hours, as employees waste much time meeting their private visitors. What's more, there are some employees working in public sector that do not obey with rules and regulations. He also added, in the case of some training courses, the employees who take part in the training programmes are usually assigned by mediation and sometimes from inappropriate departments of the organization. Moreover, the changes and instability within the Libyan government departments and organizational structure have led to changes and amendments of the rules and regulations. These administrative mistakes, changes , and gaps created instability within the Libyan management system and caused delays in achieving organizations' objectives and hinder the organizations efforts to introduce management development and innovations and make the adoption of any new management or enhancement system very difficult.

#### **2.2.6 Libyan manufacturing industry**

After the independence of Libya in 1951, there were a number of small factories established to make light and traditional products such as fish and vegetable canning, olive oil refining, leather tanning, and processing domestic crops. These factories were owned, planed and managed by Italy's as a result of Italian occupation in 1911.

The growth in Libyan industry started during the 1970s after the great rise in oil price and production. The government changed policies and a new direction was adopted. The industrial sector (including manufacturing) was planned by and controlled by the Libyan government. The new direction and policy focussed on freeing all manufacturing industry from reliance on foreign control or ownership. During this time plenty of manufacturing industries were established making various products such as cement, plastic, iron, tyres, buses, trucks, tractors, chemical, electronics, textiles, paper, food, and furniture [57].

In the 1990s, with Libya as a developing country, the manufacturing sector was highly centralised by public policy. Thus, the Libyan manufacturing sector was split up into six subsections namely:-

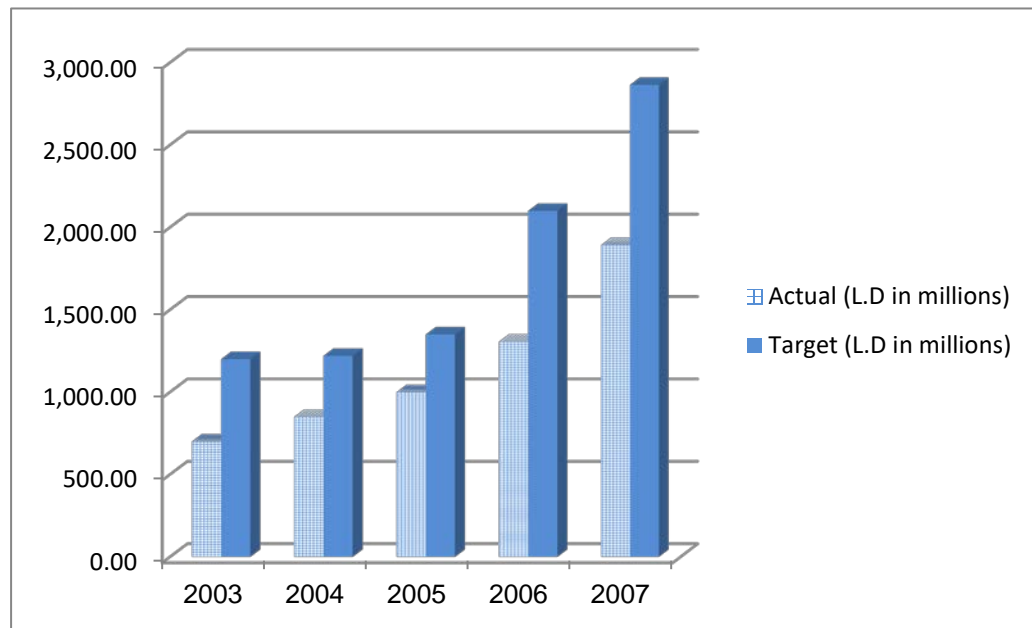
- 1- Chemical industry.
- 2- Cement & building materials industry.
- 3- Food industry.
- 4- Electrical and engineering industry.
- 5- Textiles & furniture industry.
- 6- Mineral industry.

Most of these manufacturing industrial companies, particularly large sized are owned by the state and supervised by the industry secretariat, (ministry of industry). The manufacturing sector employed around 29% of the Libyan manpower; foreign workers were imported in large numbers to fill in any shortage and to meet the need for skilled work [55]. The UN sanctions against Libya in 1992 to 1999 had a bad impact on the Libyan manufacturing industry as well as other industries, due to restricts on developments or improvements. As a result all of the manufactured products were consumed only locally due to either the high local demand or sometimes to the bad quality or specification to be exported.

In the 2000s and after lifting of the UN sanctions, Libya became open to the world. As a result the level of foreign labour has rapidly decreased, and the number of national employees has increased due to the graduation of skilful locals who become capable of achieving all required activities, and also because of the new government laws, decisions and plans [52].

The opening to the global market has granted Libya opportunities not only in oil and gas industry but also in other industries including manufacturing. The Libyan industrial sector has successfully contributed to accomplishing several goals that were only a vision in the past. It has also contributed to the local production directly or indirectly as inputs to other production. Despite the fact that the Libyan industrial sector made only 5.33% of GDP in 2007, it is considered one of the main target growth sectors in the national economy. At that time the Libyan manufacturing industry recorded its first positive growth in five years by increasing 1.8 % [58].

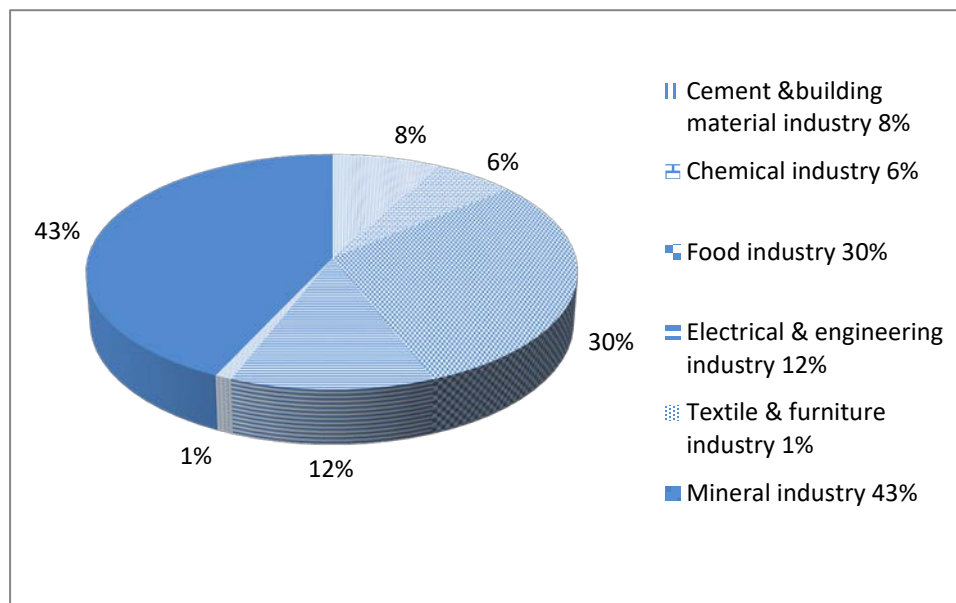
According to the 2007 annual report of CIID (the Centre for Industrial Information and Documentation), the Libyan manufacturing companies in 2007 achieved 1893.154 million L.D, this figure was higher than the 2006 production level of 1306.272 million L.D. However this figure only represented 66% of the total planned production which was 2865.972 million L.D. Figure 2.1 below shows a comparison between the actual and targeted production level for the period (2003-2007) [58].



**Figure 2.2: A comparison between the actual and targeted production level of the manufacturing industries for the period (2003-2007)**

The figure shows that there is a gap between the actual and targeted production levels. This reveals that Libyan manufacturing companies face barriers in producing the planned production, which may be many reasons such as mismanagement, poor infrastructure, lack of strategic planning, lack of quality management, and lack of following up with the latest techniques and tools. However, the figure also shows a positive indication that there is a continuous improvement in the achieved production for the same period. It is worth mentioning that there are a few companies operating in cement, steel and iron, petrochemical, and animal food industry, which together make 74% of the overall production. This means that the rest of the manufacturing companies make a very low production sharing the remaining 26%.

Figure 2.2 shows the contribution of the six subsections industries for the whole production volume. The figure reveals the percentage of each subsection industry in terms of their contribution to the total production volume. The highest contribution of 43% is made by the mineral industry, and then food industry, which achieved 30%, followed by the electrical and engineering industry, cement and building material, and chemical industry with 12%, 8%, and 6% respectively. The lowest contribution was 1 % which was achieved by the textile and furniture industry [58].



**Figure 2.3: Contribution of the subsections industries  
in terms of total production volume**

The manufacturing industrial companies in Libya are divided into three sections according to their size as following [49] :-

- A company with equal or more than 500 employees is considered ‘large’
- A company with employees 100-499 is considered ‘medium’
- A company with less than 100 employees is considered ‘small’

#### **2.2.6.1 The government support to manufacturing companies**

The Libyan government support includes the encouragement of foreign capital investment, with tax being exempted. In 2000, the government established the PIB (Privatization and Investment Board). The PIB aims to encourage foreign investors to support local companies in their transfer to the implementation of new tools and techniques, to help them in the development of the Libyan technical workforce, and to assist in the improvement of local

production for global market. The government support this sector, in order to promote and attract investors and also to enhance manufacturing industries export competitiveness. Reform to the export policy has been made by cancelling all customs duties on most capital imports. The government no longer monopolise the imports and foreign investment is now not only possible but also encouraged in manufacturing industry and other sectors.

#### **2.2.6.2 Quality management and six sigma in Libyan manufacturing industry**

To date, there is a lack of literature on the implementation of six sigma in Libyan manufacturing companies. Therefore, to the best knowledge of the researcher this research will be the leading study in the area of six sigma in the Libyan manufacturing industry. On other hand, the literature on Libyan quality management implementation is scarce. However in 2007 Najeh and Chakib [59] carried out a study in some developing countries and Libya was among them. The study was about comparing and contrasting the quality vision and practice. The selected sample of Libyan organizations was from the oil sector only, which revealed that the proportion of manufacturing companies in Libyan oils firms constituted just 39 % of the total study sample. This was compared to the other countries in the study where the selected sample were from different sectors including(manufacturing) .Therefore the Libyan sample was inadequate to represent the whole culture of quality to all Libyan industrial sectors.

The study showed the factors that were identified as critical which are: supplier-customer chain, processes improvement, problem solving, and quality management system. On the other hand, factors, which were considered no critical, are - quality approaches, support services, benchmarking based on competition, business process, and closer supplier relationship management. However, the scope of this study was narrow (oil sector only) focusing on quality factors rather than on what are the principles and practices of quality management to what extent they are successfully implemented. Therefore, there is clearly need to investigate the extent to which quality management practices are being implemented in Libya, especially in the manufacturing sector and what areas need to be further improved.

#### **2.2.6.3 Difficulties, barriers and possible solutions to the Libyan manufacturing sector**

As mentioned previously, Libyan manufacturing industries face many technical difficulties and barriers, which can be summarised as follows:-

- Management instability and lack of implementing modern quality management system and contemporary techniques and tools such as six sigma.
- Libya, as a developing country, the manufacturing sector is highly centralised as an instrument of public policy.
- Incomplete and poor local standards which are frequently incompatible with international standards
- Inadequate technical infrastructure
- Lack of government initiatives to promote manufacturing awareness and practices.
- Lack of training programmes
- Lack of expertise in quality management and six sigma

Libya, currently at a turning point, both politically and economically. Since the revolution of 17 February 2011, many obstacles facing trade and industry are now being highly addressed, and here are some possible solutions to keep Libyan manufacturing companies survive and compete with those foreign companies and products entering Libya: -

- To adopt and implement modern and advanced quality systems and techniques that help in cutting costs and improve processes and product quality such as six sigma.
- To improve the work infrastructure by establishing manufacturing complexes.
- To concentrate more on the training programmes needed to improve employees' skills.

The Libyan government have recently taken proactive steps towards these goals, by issuing many scholarships to Libyan students to study abroad at well-known foreign universities across the world, to pursue their studies in various fields and degrees such as Masters and Doctorate programmes as well as training courses, aiming to increase the number of highly qualified professionals in all sectors, which will help in building and development of Libya in the near future.



# Chapter Three

## 3 Research Methodology

### 3.0 Introduction

This chapter describes the detailed research methodology that will be utilized to meet one of the key aim and objectives of this research. It focuses on methodology matters, justifies the selection of the research method and shows the reasons behind the selection made. Furthermore, it provides a description of the research philosophy, the research approach, the research strategy, and time horizon.

### 3.1 Definition of research methodology

Research methodology varies significantly, and it can be described as a systematic approach taken towards the collection and analysis of data [60]. Adopting an efficient and methodical tactic can progress many of the advantages and characteristics of an excellent research project. Adam and Haley [61] stated that “research methodology is the overall approach in which the individual research technique and tools are utilized to meet the research objectives”. Consequently, a clear and explicit statement of the research objectives is essential, to enable the selection of a suitable research methodology and data collection technique. Zickmund [62] views research methodology as the procedures of collecting and analysing the required data. There are no certain rules as to which one to choose when conducting research, it depends on the nature and scope of the research, the research aim, the problem statement, and the source of data, hypotheses, and the overall available time the researcher has. Research methodology is the way of how the researcher goes around or about doing his/her research. Therefore, there is no single way could be considered to be the best [63].

Blaxter et al. [64] stated that the way of selecting the research methodology depends on some important factors such as the amount of time available to the researcher, the way in which the research question is shaped, the researcher’s skills, what the researcher is interested in finding out and the reasons for conducting the research.

Sanuders and Thornhill [65] stated that a research methodology can be conducted in multiple-ways , it is a series of sequential phases which must be followed in order to achieve and complete the research project. They presented the research onion as shown in figure 3.1 as a way of depicting or showing the possible choices of research philosophy, research approach, research strategy, and data collection methods

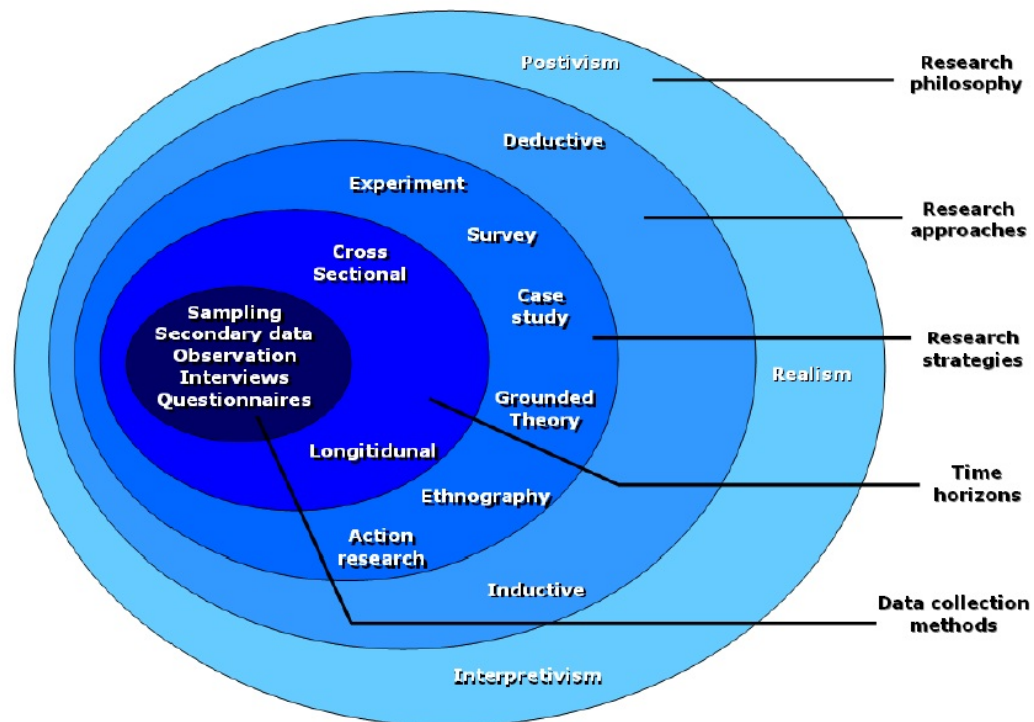


Figure 3.1: The research onion. [65]

### 3.2 Research philosophy

There are two main traditional research philosophies: the Positivism philosophy and Interpretivism philosophy, which is known also as the Phenomenology philosophy. Philosophers argue about which one of the two philosophies is considered to be the best and can be utilized to conduct a research [60]. Both philosophies have an significant role to play in business and management research [65].

The basic idea of the Phenomenological philosophy is based on people sharing their experience with others. It relies on the meaning that people share their own experience rather

than on the external factors. Phenomenology philosophy is one of a group of approaches of interpretative methods, in other words; people build their own words to give meaning to their own facts. On the other hand, the fundamental idea of the positivism philosophy is based on the idea that the social world does exist externally and its properties are measured by using objective approaches instead of being inferred subjectively through sensation, reflection or intuition [66].

Collis and Hussey [60] argued that, despite the fact that there is broader use of the positivism philosophy, this type of research is criticized as follows : reality can only be defined subjectively but not objectively, quantitative researches take the natural knowledge as a model, dealing with persons not as a social person performing independently, and consequently respondents should be dealt as objects and producers of data. The phenomenological philosophy was developed as a result of criticisms of the positivistic philosophy, to stress the subjective aspects of human activities by concentrating on the meaning rather than the measurement.

Hair and Money [67] stated that the elements of positivism research are the powers of a quantitative research and a structure that is not common in a qualitative research. In qualitative research, participants are free and able to comment with their own words and this is not revealed by a structured questionnaire. Quantitative methods offer objective testing and data is measured by applying statistical techniques; the researcher's view obviously has no effect on the result, although it has an influence on the design questions that are asked in the survey. Johnson and Duberley [68] said that although positivism research has recently been under increasing attack from other orientations, it is still the dominated epistemological orientation of the management discipline. Table 3.1 displays the main features and the assumptions of each philosophy.

**Table 3.1: Features of positivistic and phenomenological philosophies [60].**

<b>Positivistic philosophy</b>	<b>Phenomenological philosophy</b>
Yields quantitative data	Yields qualitative data
Large samples are used	Small samples are used
Researcher must be independent of what is being investigated	Researcher is part of what is being investigated
Concerned with testing & measuring	Concerned with generating theories
Data is highly specific and precise	Data is rich and subjective
The location is artificial	The location is natural
high Reliability	low Reliability
Low Validity	high Validity
Generalises from sample to population	Generalises from one setting to another

Creswell [69] stated that although it is possible to find out more than one assumption linked with each philosophy, there is no possibility to identify any one philosopher who points to aspects of one specific view. This opinion is supported by Easterby-Smith et al.[66] who attributed that, despite the fact that each philosophy has its particular assumptions and structures and the distinction between philosophies can be very obvious at the philosophical level.

Saunders et al. [65] mentioned that individual quantitative and qualitative methods and techniques do not exist in isolation. This view is supported by Johnson and Duberley [68] who stated that some of the researchers who claim to refuse positivism have not completely avoided all the features of the positivism approach. Hence, several researchers began to find a middle vision between the two philosophies in the management researches by developing new approaches and techniques [70]. This option has gradually been supported within business and management researches and studies where a single research study could use and

utilize both quantitative and qualitative techniques and tools in combination and also using primary and secondary data.

In combination, the assumption or the idea, is that both philosophies have strengths and weaknesses; and that the weaknesses in each philosophy will be replaced by the strengths of another [71]. Teddlie and Tashakkori [72] argued that multiple approaches and techniques are valuable when they offer better possibilities to the researcher to answer the research question or problem, and to trust more the value of the research outcomes and findings. The choice of multiple approaches and techniques provide the researcher the ability to use different methods for different purposes in a research, for instance, if the researcher needs to effectively design the questions of the questionnaire, a preliminary interview may be conducted in order to provide a sense for the key issues which must be taken into consideration in the questionnaire development. Furthermore, researchers are not possible to be entirely objective; they have certain views and opinions about the problem under investigation and they practise their own expressions in reporting it [73].

For this research, based on the previous discussion, the extensive range of the literature, the intention to generalise the findings and outcomes of the research, and the necessity to conduct preliminary interview to identify the reasons and barriers which must be considered in the main questionnaire survey; the researcher is, consequently, seeking some kind of compromising between positivist and phenomenologist philosophies; however the researcher leans more on the positivist philosophy as a main philosophy. This combination in the research philosophy helps the researcher to improve the understanding and knowledge about the problem under investigation.

### **3.3 Research approach**

Inductive and deductive are the two main research approaches [74] inductive approach is a study where a theory is developed from observation of reality, inductive approach is described as moving from specific to general, which is different from deductive approach. Deductive approach is a study where a conceptual and theoretical structure is developed and tested. The deductive approach is described as moving from general to specific [60]. Yin [63] stated that inductive approach is in general an investigation to identify a social or human issue from different views. While deductive approaches move from theory to its empirical investigation

Saunders et al. [73] said the two approaches differ from each other as follows: the researcher in an inductive approach aims to understand of the nature of the problem and to have a sense of what is going on. Usually the outcomes of these researches would be the formulation of theory. However, the researcher in a deductive approach aims to be more independent of what has been investigated, to be more controlling, and to use an effectively structured methodology. In the deductive approach usually the researcher aims to generalise the outcomes and the results. Table 3.2 shows the differences between deductive and inductive approaches [75].

**Table 3.2: Differences between deductive and inductive approaches[75]**

<b>Deduction emphasizes</b>	<b>Induction emphasizes</b>
Scientific principles moving from theory to data	Gaining an understanding of the meanings humans attach to events
the need to explain causal relationships between variables	a close understanding of the research context
the collection of quantitative data	the collection of qualitative data
the application of controls to ensure validity of data	a more flexible structure to permit changes of research emphasis as the research progresses
A researcher independence of what is being researched	a researcher is part of the research process
the necessity to select samples of sufficient size in order to generalize conclusions	less concern with the need to generalize
Wealth of literature:- More sources, definition of a theoretical framework	Wealth of literature:- Less sources, data generated and analysed
Deductive approach is quicker to complete	Inductive needs time
Deductive approach is a lower-risk strategy	Inductive – fear that no theory will emerge

From what has been mentioned and discussed, it could be concluded that the key difference between inductive and deductive approaches is the availability of the literature and the theory and the findings, outcomes that the researcher catches at the end of the research. The inductive approach develops a theory and ends up with a theory, while the deductive approach examines the theory and ends up with findings and results that could be generalised.

For this research, the researcher uses and utilizes an extensive range of literature (the use of literature supports and helps in designing and developing the questions of the interview and questionnaire to identify the barriers behind the lack of six sigma in Libyan manufacturing companies), due to the great level of control over the research processes and procedures as well as the plan to generalise the findings and results of the research, it is considered that the deductive approach is the most and suitable and appropriate approach for this research.

### 3.4 Research strategy

Saunders et al. [76] cited that research strategy is a plan of how a researcher will go about answering the research question. It is a methodological relation between the philosophy and following choice of methods of collecting and analysing data. To find the most suitable research strategy is considered one of the critical stages in researching for the subject under investigation, and the research's success depends on the method and technique in which primary data would be collected, analysed, and produced. However, several research strategies can be utilized for the primary data research. Every single strategy has its own way in collecting and analysing the data and also each strategy has its own logic and own advantages and disadvantages [77] .

Saunders et al. [76] introduced a list of eight different kinds of research strategies. As following: Survey; Case Study; Ethnography; Action Research; Experiment; Grounded Theory; Archival Research, and Narrative Inquiry . Yin [77] presented five kinds of research strategies as shown in table 3.3. He mentioned that each strategy depends on some conditions that should be taken in consideration when selecting the most suitable research strategy. These conditions are:-

- The form of the research question
- The control that the researcher has over behavioural events
- The focus on contemporary events.

**Table 3.3: Relevant situations for different research strategies.**

Strategy	Form of the research question	Required Control over behavioural events	Focus on contemporary events
Survey	What, Who, Where, How much, How many?	No	Yes

Experiment	How, Why?	Yes	Yes
Case study	How, Why?	No	Yes
Archival analysis	What, Who, Where, How much, How many?	No	Yes, No
History	How, Why?	No	No

Different traditional research has resulted in a number of potential research strategies. Specific research strategy might be linked with one of the research philosophies and also to research approaches (deductive or inductive). However, there are usually open boundaries between research philosophies, research approaches, and research strategies. The key of selecting the research strategy or strategies is that the researcher achieves a sensible level of coherence throughout the research design, which will enable him/her to answer the research question and to meet the research objectives. The selection of research strategy will consequently be guided by the research question and objectives, the coherence with which these link the research philosophy, research approach and the purpose, and also concerns the extent of existing knowledge, the amount of time available and resources the researcher has, and access to potential participants and to other sources of data [76].

For this research, the survey strategy has been selected as the research strategy. The justification of this choice can be summarised as following:-

- Because the positivism philosophy has been selected as the main philosophy for this research. Furthermore, survey strategy is usually linked with deductive research approach, which is the selected approach for this research.
- As ‘what’ is the question under investigation, then the survey strategy would be the preferred method for this kind of questions.
- As the purpose of this research investigation is identifying the reasons and barriers behind the lack of six sigma in Libyan manufacturing industry, which will cover a broad range of different participants in different companies, therefore the survey strategy will be better than other strategies such as a case study which covers just a small number of participants in a few companies.



- Surveys that use questionnaires are common as they offer the collection of standardized data from a large population in a very economical way, and also allow a simple comparison.
- People in general perceive survey strategy as authoritative, and is both relatively easy to explain and understand.
- Survey strategy allows the researcher to gather quantitative data that can be analysed quantitatively by using descriptive and inferential statistics.
- Data collected by using a survey strategy could be used to propose possible details for specific relationships between variables and to create models of these relationships.
- Survey strategy allows the researcher more control over the research processes.
- Findings of representative data can be generated at a lower cost than collecting the data for the entire population.
- The researcher is independent of what is being investigated
- The questionnaire is not the only data collection technique within the survey strategy, but also structured observation and structured interviews go with this strategy.
- As this research is a PhD programme, and the availability of time that the researcher has is limited, therefore the survey strategy is considered the suitable one than others because it takes less time.

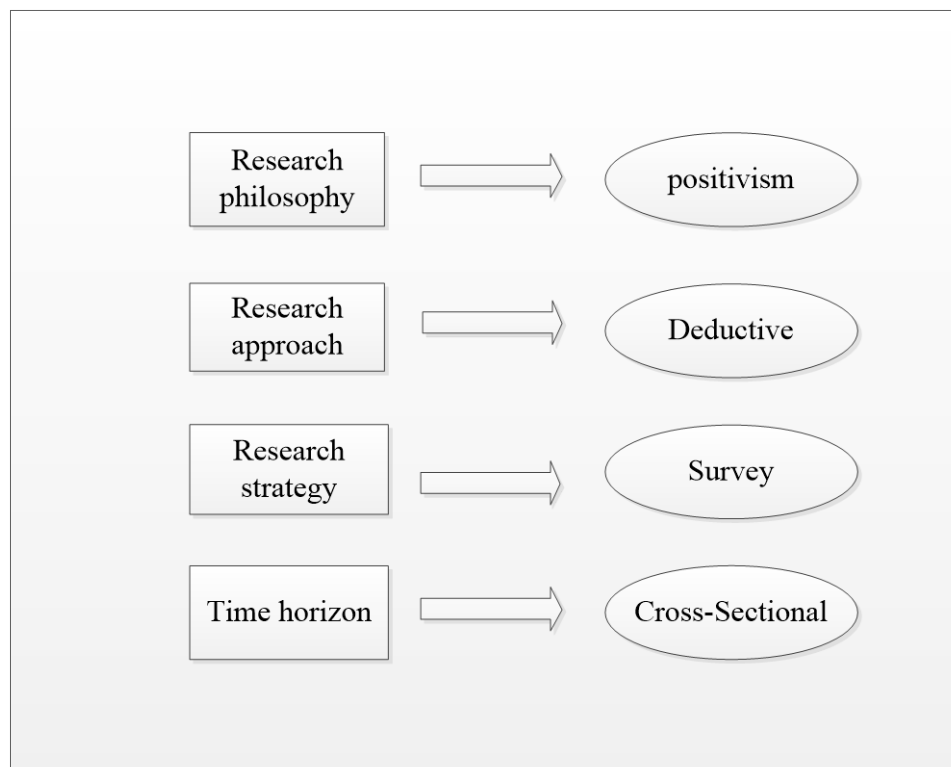
### **3.5 Time horizons**

The time horizon is the time plan within which the project is planned for completion [73]. There are two kinds of time horizons as shown in figure 3.1 the research onion. The cross sectional time horizon is known as a snapshot taken at a particular time and most research projects undertaken for academic courses are certainly time constrained. Cross sectional studies often employ survey strategy where data must be collected at a certain point; this is used when the investigation is concerned with the study of a particular phenomenon at a specific time. The longitudinal time horizon for data collection refers to the collection of data repeatedly over an extended period, and is used where an important factor for research is examining change over time [76]. Thus, this research is cross-sectional time horizon as the required data are gathered at one point in time.

### 3.6 Chapter summary

The researcher in this chapter selected and justified the research methodology which includes, research philosophy, research approach, research strategy, and time horizon, the selected research methodology can be summarised in figure 3.2.

In the next chapter, the researcher will introduce data collection and sources of data, methods of data collection will also be presented, discussed to select the suitable data collection method for this research.



**Figure 3.2: Research methodology selected**

# Chapter Four

## 4 Data Collection

### 4.0 Introduction

The fundamental idea of data collection in any research study is to search and gather information to address the question being asked. In other words collecting data is the processes of gathering and measuring information on variables of interest, in a well-known systematic method which enables answering the posed research question [76].

### 4.1 Sources of data

There are two main approaches or sources to collecting data, where information can be obtained from primary or secondary sources. Primary data or sources refers to data obtained by the researcher first hand on the variables of interest for the research, whereas secondary data refers to data gathered from already existing sources which needs only to be extracted [78].

#### 4.1.1 Secondary sources of data

Secondary data is necessary for most organizational studies. As mentioned above, secondary data refers to data already available or collected by someone other than the researcher who conducts the current study. The sources of this data can include books, academic journals, conference papers, government publications, census data, database, statistical abstracts, annual reports, theses, and organizations records [78]. Blaxter et al. [64] presented explanations for utilizing secondary data, as it makes sense to utilize it if the information you want already exists in some form, because it is hard to run a research study away or in isolation from what has already existed, because it could shed light on or be complementary to the primary research data. Consequently, secondary data provides the researcher with a wide understanding and huge range of data on the subject under investigation.

For this study, the researcher is collecting secondary data from multiple sources that are considered reliable; the official Libyan information and documentation centres, textbooks,

journal articles, conference papers, Libyan census data, Libyan government annual reports, and some previous studies will be used, utilizing the Northumbria University database and computer network which provide a huge number of electronic books, academic journals and conference papers as well as the University library which has a comprehensive number of textbooks.

#### **4.1.2 Primary sources of data**

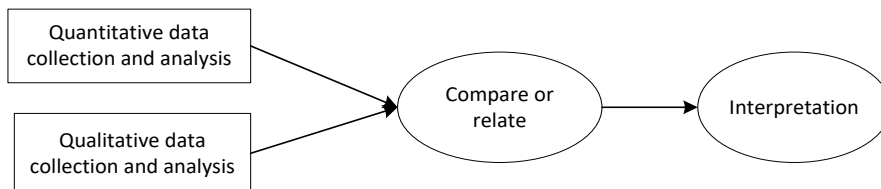
Primary data as mentioned earlier; is data or information that is directly gathered and obtained first hand by the researcher for the purpose of the research under investigation. There are many methods of collecting primary data, such as surveys, when individuals provide information when interviewed, questioned, or observed. As mentioned in chapter three, for this research, the survey has been chosen as the source of primary data.

### **4.2 Data collection methods**

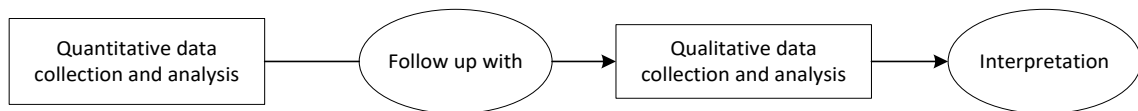
Interviewing (qualitative data), and administering questionnaires (quantitative data) are the most widely used data collection methods in survey research [78]. Hence, the primary data collection for this research will be obtained by conducting both an interview and a questionnaire. This technique is known as mixed methods data collection, which has been defined by Creswell [69] as “a procedure for collecting, analysing, and “mixing” both qualitative and quantitative research and methods in a single study to understand a research problem”. There are many factors that influence the collection and combination of both qualitative and quantitative data in a research study. Indisputably, both methods are available for utilisation in studying research problems. In addition, due to all methods of data collection having limitations, the utilization of mixed methods can neutralise or cancel out some of the weakness or disadvantages of certain methods, in other words, data sources can complement each other. This approach of combining methods is called triangulation. Thus, there is a broad consensus that mixing different kinds of methods can strengthen a research [79].

There are three major designs or prototypical versions of mixed method data collection as shown in figure 4.1 [76] :-

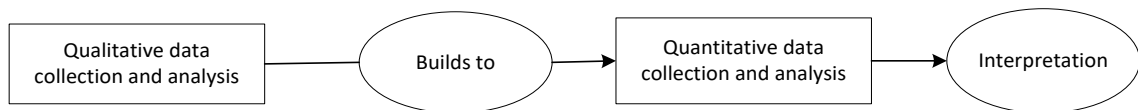
### 1- The convergent parallel design



### 2- The explanatory sequential design



### 3- The exploratory sequential design



**Figure 4.1: Prototypical versions of the main mixed methods [76]**

In a mixed method study, the issue is how to make a decision about giving priority to qualitative or quantitative or to do them concurrently [80]. Unlike the frame of reference of data collection in the execution decision, here the focus will be on the priority given to qualitative or quantitative research as it happens all over the data collection procedure. This procedure could be defined as including how the research is presented, the use of literature, the aim of the research and the research problem, the data collection, the data analysis, and the interpretation of the outcomes or findings. However, the researcher who uses mixed methods can give equal priority to both qualitative and quantitative research, emphasize quantitative more, or emphasize qualitative more. This emphasis might come from practical restraints of data collection, the need to understand and extract data from one form before proceeding to the next, or the audience's preference for either qualitative or quantitative research. In almost all cases, the decision rests on the researcher's comfort level of one tactic as opposed to the other [81].

For this research, the exploratory sequential design has been chosen to be the data collection method approach. The main reason of choosing the exploratory design is that one of the key objectives of this research is to explore the reasons and barriers behind the lack of six sigma use in LMCs. It was found in the literature review that there are a wide range of different barriers facing companies around the world in the adoption and implementation of six sigma, so it has been decided to start with conducting interviews to collect qualitative data and determine which barriers are faced by the LMCs in order to narrow down the questionnaire questions to make respondents more interested and to get a better response rate. These barriers will then be investigated and quantified more by conducting the questionnaire based on the interviews results. Furthermore, the quantitative data collection in this approach is the second phase which means that it is built upon the outcomes of the qualitative data. Consequently, it will be well revised and any shortage or mistakes occurring in the qualitative data can be avoided in the quantitative phase. Also the advantages of qualitative data can be carried forward to the quantitative data phase and this helps, as the researcher leans more on the quantitative data, and also on the positivist philosophy as a main philosophy which produces quantitative data, as explained in chapter three.

### **4.3 Interviews**

Interviews are considered one method of collecting data where respondents are interviewed to extract and obtain information on the issue of interest. Interviewing is a beneficial data collection method involving oral communication between the researcher and the interviewee. Interviews are commonly and widely used in survey designs and in exploratory and descriptive research [82]. Interviews can be structured or semi structured, or unstructured, and conducted face to face, by telephone, or focus group [78].

#### **4.3.1 Types of interviews**

##### **4.3.1.1 Structured interviews**

A structured interview can be defined as a method of collecting data using a questionnaire in which each interviewee is asked the same set of questions with the same order by an interviewer who writes down the responses. All the questions are based on structured, closed-ended questions [83]. In the structured interview, the interviewer has a list of predetermined and standardised questions to be directed to the interviewees in order, and the interviewer cannot deviate from the interview schedule or probe beyond the answers received

which means that they are not flexible and new questions cannot be asked during the interview, so a schedule must be followed [76].

#### **4.3.1.2 Semi-structured interviews**

Semi-structured interviews can be defined as a method of collecting data, in which the interviewers ask about a set of themes using some predetermined questions, but the order can be varied in which questions are asked and the themes are covered. The interviewer could choose to ignore some areas and questions and ask other questions as appropriate [83]. The semi-structured interview covers a set of open-ended questions based on the areas the interviewer needs to cover. The open-ended nature of the questions define the issue under investigation but offer chances for both interviewer and interviewee to discuss some areas in more detail. If the interviewee faces difficulty answering a question or gives only a brief or short response, the interviewer is able to hint or use cues or prompts to motivate the interviewee to think through the question further. In a semi-structured interview, the interviewer is also free to probe the interviewee to elaborate on the original answer. Semi-structured interviews are valuable when collecting attitudinal data on a large scale, or when the study is exploratory and it is not possible to draw up a list of possible pre-codes due the unknown nature of the topic [82].

#### **4.3.1.3 Unstructured interviews**

Unstructured interviews can be defined as a method of collecting data in which the respondents talk openly and broadly about the subject with as little direction from the interviewer as possible. Although the interviewer has no predetermined list of questions, he or she will have a clear idea of the issues to be explored [83]. Unstructured interviews are sometimes referred to as “in depth” or “discovery” interviews because they have very little structure at all. The interviewer starts the interview with the goal of discussing a limited number of issues, often as few as one or two. An interview schedule may not be used, and even if it is, it would usually contain open-ended questions that could be asked in any order. Some questions may also be added or cancelled as the interviewer progresses [82].

#### **4.3.1.4 Face-to-face interviews**

Face-to-face or personal interviews are really labour intensive, but can be one of the best ways of gathering high quality information. Face-to-face interviews can be advisable when the subject area is really sensitive, if the questions are complicated or if the interview is predicted to take a long time.

Compared to other ways of collecting information, face-to-face interviewing provides a better level of flexibility. A skilful interviewer can clarify the aim of the interview and motivate potential participants to take part; they can also explain questions, clarify misunderstandings, provide prompts, probe answers and follow up on new concepts in a way that is not possible with other methods [82].

#### **4.3.1.5 Telephone interviews**

Telephone interviews are a very operative and economical way of gathering information, where the participants to be interviewed are all reachable via the telephone. They are not a suitable method of collecting data for deprived participants, where telephone ownership is potentially low or where participants might be ex-directory. However, telephone interviewing is ideally appropriate to busy professional participants, such as general practitioners. Telephone interviewing is also convenient and practical when the participants to be interviewed are broadly geographically dispersed.

One of the main drawbacks of telephone interviews is that it is not easy to combine visual aids and prompts and the participants are not able to read cards or scales. Telephone interviews are also length limited, though this varies with topic area and enthusiasm. However prior appointments can be made for telephone interviews and stimulus material for participants to look at in advance of the interview can be sent. A prior appointment and covering letter could improve the response rate and length of interview. It is also vital to note that any results derived from telephone interviews of the general population should be interpreted to take the non-responders into account who might not have access to a telephone or might be unlisted [82].

#### **4.3.1.6 Focus group interviews**

Collecting data from groups of participants sometimes is better than from a series of individuals. Thus, focus groups could be suitable to collect certain kinds of data or when using other ways of data collection might be difficult to obtain the required information. Focus group interview is commonly used in the private sector, mainly in market research. However in the public sector it is recently being used increasingly [82].

Focus group interview may be used when there are limited resources for conducting interviews, and also when identifying a set of individuals who share the same factor is



possible and it is desired to gather the views of many participants within a sub group of the population.

#### **4.3.2 Selection of interview technique**

For this study, the semi-structured interview was chosen as the most suitable technique, and will be conducted by telephone. The decision of choosing the semi-structured interview was based on what some authors said about the advantages of this type of interview. Saunders et al. [65] stated that the use of interviews helps to collect valid and reliable information which is relevant and useful to the research. He added, semi-structured interviews are used to collect qualitative data in research studies in order to not only reveal and understand ‘what’ and ‘how’ but also to emphasize more on explaining the ‘why’. He also said that semi-structured interviews can be the most suitable technique when either the questions are complex or open-ended or where the questioning order or logic might require being different from one interviewee to another. This view is supported by Jankowicz [84] who said that semi-structured interviews are a powerful data collection method which allows for flexibility that might be needed because the interviewer cannot ask the same questions precisely in each interview. Mason [85] cited that the semi-structured interviews are a relatively informal discussion rather than formal questions and answer and the interviewer has no need to have a list of structured questions and he/she could have a set of themes, subject areas or issues to cover.

Interviews will be conducted by telephone due to the current unstable situation in Libya, and also because the EU had imposed bans on all Libyan airlines from flying into EU Members’ airspace during this period, fearing the country’s political and security situation could affect passenger’s safety. These reasons prevented the researcher from flying back to his home country to conduct the interviews. Consequently, it was decided to conduct them by telephone. The researcher had to make a special subscription for making international calls as they are very expensive.

#### **4.3.3 Generation of interview questions**

The semi-structured interview open-ended questions were largely designed and generated from the six sigma literature review in chapter two. In addition, four questions were posed from the researcher, the purpose of which is to specifically identify the reasons and barriers

behind the lack of six sigma implementation in LMCs, which is one of the key objectives of this research. Table (4.1) shows the interview questions and their sources.

**Table 4.1: Interview questions and their sources**

<b>No</b>	<b>Interview question</b>	<b>Source</b>
1	Can you tell me what your position is and how long have you been employed in your company, what type of industry does your company operate in?	Question developed by the researcher
2	Have you ever heard of the term six sigma? What is your knowledge about six sigma?	Antony et al. [30], Buch & Tolentino [86], Chakrabarty & Tan [32, 87], Feng & Manuel [88], Gamal[89], Kumar et al. [31, 90], Raghunath & Jayathirtha [33]
3	Has your company ever implemented six sigma? If no, why?	Question developed by the researcher
4	Do you think six sigma is a complicated technique and are you uncertain about its results and benefits?	Chakrabart & Tan [32], Hendry [91], Hensley & Dobie [18], Martins et al. [92], Raghunath & Jayathirtha [33], Sehwal & DeYong [93], Sinthavalai [94]
5	What kind of quality management systems has your company used? Are you satisfied with the current system, and feel that there no need for six sigma?	Antony & Desai [95], Gamal [89], Kumar et al. [31, 90]
6	Does your company run any kind of training related to six sigma?	Gamal [89], Hendry [91], Kundi [35], Kwak & Anbari [96], Mallick et al. [97], Raghunath & Jayathirtha [33], Kumar[98], Sarkar & Acharya[99], Snee[100]
7	Are there any six sigma trained professionals in your company?	Buch & Tolentino [86], Gamal [89], Hendry [91], Kwak & Anbari [96], Snee [100], Taner et al. [101]
8	Are there six sigma training providers	Question developed by the researcher

	available in Libya?	
9	Do you think introducing six sigma to your company is too costly?	Antony [102, 103], Kumar et al. [31, 90], Sinthavalai [94], Taner et al. [101]
10	Does your company have sufficient financial resources to implement six sigma?	Antony et al. [30], Feng & Manuel [88], Gamal [89], Kokkranikal et al. [34], Kundi [35], Raghunath & Jayathirtha [33], Taner et al. [101]
11	Do you have sufficient time to implement six sigma?	Antony et al. [30], Buch & Tolentino [86], Chakrabarty & Tan [32, 87], Feng & Manuel [88], Gamal [89], Kokkranikal et al. [34], Taner et al. [101]
12	Is there a good communication between all departments in the company?	Antony et al. [104], Gamal [89], Kokkranikal et al. [34], Kundi [35]
13	Is there a culture change effect (resistance to change) for introducing any new technology or technique?	Antony et al. [30], Feng & Manuel [88], Gamal [89], Kokkranikal et al. [34], Kundi [35], Mallick et al. [97], Sarkar & Acharya [99], Raghunath & Jayathirtha [33], Taner et al. [101]
14	Does the top management show no interest for introducing six sigma, in other words, is there lack of top management commitment?	Dahlgaard & Dahlgaard-Park [105], Gamal [89], Kundi [35], Mallick et al. [97], Raghunath & Jayathirtha [33], Sarkar & Acharya [99], Sehwal & DeYong [93]
15	Are the company's customers satisfied? Are they happy with the quality of the products?	Hensley & Dobie [18], Kumar et al. [31, 90], Mallick et al. [97], Martins et al. [92], McAdams & Evans [106]
16	What are other reasons or barriers facing your company to start implementing six sigma?	Question developed by the researcher
17	Do you think that your company is interested in implementing six sigma in the short term?	Chakrabarty & Tan [32, 87], Gamal [89], Kokkranikal et al. [34]

#### **4.3.4 Pre-testing and piloting the interview questions**

Many authors expressed their belief about the importance of conducting a pilot study. Ghauri et al. [107] said that the pilot study is a test that checks the understanding of interviewees in terms of the research problem and interview questions, and also ensures that the scheduled questions in the interview are valid in terms of research objectives. Thus, the aim of piloting the interview questions is to give the researcher an idea about the problems, which may appear in the future. For example, misunderstanding of questions by interviewees, repeating of questions, the length of questions, and time needed for conducting an interview. Before conducting the pilot study, interview questions were checked and revised by the supervision team and also by two six sigma experts. The interviews were then pilot tested by conducting two interviews with participants from Libyan manufacturing companies. The pilot study enabled the researcher to measure the average length of time of an interview and also to get minor comments regarding clarification of some questions. This gave the researcher more confidence about the validity of the questions before proceeding to the main interview stage.

#### **4.3.5 Conducting the main interview**

Criteria of the participating interviewees in this research were based on their experience and position in their companies. The main targeting interviewees were those who are responsible for quality management systems in their firms such as quality managers and technical managers, and also managers who are responsible in decision making such as executives and chairmen. Interviews were conducted with ten interviewees during the period June 2015 and July 2015. The ten interviewees were from different Libyan manufacturing companies, to allow more varied and comprehensive feedback to be obtained. Most of the interviewees were from middle management such as quality managers, supervisors, technical managers and one only was a general director manager. In addition to the ten, another interview was carried out with the quality manager of the Libyan National Centre for Standardization and Metrology (LNCSM). The LNCSM is a governmental centre responsible for drafting and issuing standards in all fields, LNCSM develops and improves quality methods and encourages Libyan organizations to adopt quality systems and techniques. This was a special interview with LNCSM to know their role in the contribution and diffusion of quality techniques like six sigma and to know their impact as a governmental department on Libyan organizations.

The processes of conducting interviews, which has been advised by many authors Sekaran [108], Malhotra and Birks [109], were adopted in this stage of the research as described below:-

- Before conducting the interview, the researcher sent a covering letter to all potential interviewees, describing and declaring the purpose of the interview, see appendix 1&2. Each interviewee received a list of the interview questions to look over before conducting the main interview.
- To avoid any confusion caused by language barriers, all interviews were conducted in Arabic instead of English, however, Arabic and English version of the interview questions was given to all interviewees, including a simple glance about six sigma, see appendix 3.
- Each interviewee was contacted by phone to organise a suitable and convenient time for conducting the interview.
- At the start of all interviews, the interviewee was appreciated for giving the opportunity to be interviewed and reassured about the confidentiality.
- Each interview began with general, easy questions to make the interviewee feel relaxed, confident and to encourage them to talk freely. Then questions that are more specific were asked and the interviewees were probed to obtain precise responses. In some questions, when necessary, the interviewees were asked for more clarification and elaboration. Every effort was made to let interviewees express their own thoughts and ideas in order to obtain meaningful and useful information.
- At the end of each interview, the interviewees were asked if they want to add anything or if they have any questions to ask and were also asked for permission to have follow-up talks if that was necessary for the future.
- Despite the importance of a tape recording, the researcher did not use it because most of the interviewees did not consent to record their interviews.
- All interviews were ended by thanking the interviewees for giving their time and also for their effort and co-operation
- After finishing each interview, the researcher immediately wrote down all the interview using the notes taken during the interviews to make sure that all fresh information was not lost and to avoid the misinterpretation of information at a later time.

#### 4.3.6 Interview data analysis

There is no standardised method for analysing qualitative data. One frequently used technique is to quantify it, in other words, convert the qualitative data into numerical data. This can be informally done, when the purpose is to count the frequency of certain events or of particular reasons that have been mentioned by interviewees [60, 73]. Punch [110] said that quantifying qualitative data offers the capacity to present a great amount of data, and it is a very useful supplement to the most significant means of analysing qualitative data. Thus, in this research, it was decided to quantify qualitative data gained from the interviews. In addition, some valuable statements from the interviewees were quoted where appropriate to support and enhance the research results.

As mentioned earlier, the purpose of conducting these interviews is to identify the reasons and barriers behind the lack of six sigma use in LMCs, so data gained from interviews was quantitatively analysed using frequencies and percentages as shown in tables (4.2) and (4.3).

The data collected from the interviews revealed that none of the Libyan manufacturing companies have ever implemented six sigma, and this supports the researcher's claim mentioned in chapter one, which states that “ *To date there is no evidence of the adoption of six sigma in the Libyan manufacturing industry*”. However, in analysing the interview data, factors were categorised into two themes, factors that impede the adoption of six sigma in LMCs (barriers), and factors that could enable the adoption of six sigma in LMCs (enablers). It is worth mentioning that some interviewees believe that in state-owned companies, where making profits is not within their priorities, and also in small size companies, this technique is not essential. On the other hand, some interviewees argued that the absence of regulations to force the adoption of quality techniques have made companies less interested in following up with the latest quality techniques and tools.

##### 4.3.6.1 Factors that impede the adoption of six sigma in LMCs (Barriers)

The data collected from interviewees was quantitatively analysed and revealed the barriers and reasons for not implementing six sigma as shown in table (4.2). The table shows the frequency of respondents who mentioned each barrier where, for example, (100%) indicates that all ten respondents mentioned that particular barrier. The table shows that there are four main barriers to the adoption of six sigma in LMCs, which are lack of top management commitment(100%), lack of training “ trained professionals (100%), courses(90%), and

providers (90%)’’, lack of knowledge and awareness about six sigma (80%), and then cultural effect (resistance to change) (70%). These factors are perceived to be the predominant barriers and reasons to the adoption of six sigma in LMCs. There were other factors which were mentioned less frequently in response to the researcher’s probing question No 16 “what are other reasons or barriers facing your company to start implementing six sigma?”, interviewees mentioned “fear of change” (20%), “unknown to us” (10%), “lack of infrastructure” (10%), “human resource” (10%), “regulations” (10%), and “there are other alternative quality techniques” (10%).

**Table 4.2: Reasons and barriers behind the lack of six sigma use in LMCs**

<b>Items mentioned by interviewees as reason or barrier during the interviews</b>	<b>Frequencies</b>	<b>Percentage</b>
Lack of top management commitment	10	100%
Lack of six sigma trained professionals	10	100%
Lack of training courses about six sigma	9	90%
Lack of six sigma training providers	9	90%
Lack of knowledge and awareness about six sigma	8	80%
Cultural effect (Resistance to change )	7	70%
Fear of change	2	20%
Unknown to us	1	10%
Lack of infrastructure	1	10%
Human resource	1	10%
Regulations	1	10%
There are other quality techniques	1	10%

#### **4.3.6.1.1 Lack of top management commitment**

As lack of top management commitment was one of the most repeated factors. It is apparently one of the major impediments to the introduction of six sigma which is usually followed by undesirable consequences such as lack of motivation and incentives, lack of employees involvement, resistance to change, lack of customer care, and lack of following up with quality techniques and tools. However, interviewees were probed especially those from middle management to investigate the topic in more depth and understand underlying

problems. Most interviewees responded that “there is no effective management or leadership”, “managers at the top level are not suitable and they have no ability to lead the organization, because there are some wrong people in the wrong position”, they added “some leading managers at top management have no appropriate qualifications or enough experience to be in this position”, “and they do not even have a clear organization vision statement, we just do what they ask us to do”. Another interviewee said “even if there are qualified managers, unfortunately, they do not pay enough attention to following up with the latest quality techniques and tools such as six sigma”, “because it is top management’s responsibility to plan and lead the company towards the implementation of any new technique”. It can be concluded that all interviewees believed that top management neither participate in quality activities nor encourage others to do it, top management are always stuck in their offices with their own agenda which is usually irrelevant to the work programmes. This finding is consistent with other studies in six sigma; Dahlggaard & Dahlggaard-Park [105], Gamal [89], Kundi [35], Mallick et al. [97], Raghunath & Jayathirtha [33], Sarkar & Acharya [99], Sehswail & DeYong [93], found that lack of top management commitment is a barrier to six sigma adoption, and the finding is also consistent with other studies related to LMCs but in different subject areas such as Hokoma et al. (*Quality and Manufacturing Management*) [111], Arshida & Agil (*Critical Success Factors for Total Quality Management*) [112], Youssef (*Total Quality Management*) [43], Mohamed (*Quality maintenance*) [53], Sharif (*Quality Management system*) [55], Sherif (*Total Quality Management and Construction Project Management*) [113].

#### **4.3.6.1.2 Lack of training**

Another critical factor that was frequently mentioned by interviewees as a barrier is training, the results from the table (4.2) show that LMCs do not provide any training related to six sigma and also do not have any trained professionals. This can be partly attributed to the lack of training providers in Libya, but also because six sigma is not implemented in LMCs and not widely known in Libya. Although some interviewees mentioned that they spent money and time on training programmes, particularly technical and quality programmes, six sigma was not among them. However, in general, all interviewees hinted that there are not sufficient quality training programmes except for one interviewee, whose company was ISO 9001 certified mentioned that they run regular training for quality activities. However, it can be concluded from the interview results that training programmes are one of the critical factors which can be considered as a barrier for the adoption of six sigma in LMCs. Other studies in



six sigma found the same outcome as this study; Gamal [89], Kumar,M [98], Hendry [91], Kundi [35], Kwak & Anbari [96], Mallick et al. [97], Raghunath & Jayathirtha [33], Sarkar & Acharya [99], Snee [100], found that training is a barrier to six sigma adoption, and the outcome is also consistent with previous studies to LMCs but in other subject areas such as Al-Mijrab (*Difficulties Affecting the Adoption of ISO 9000*) [114], Leftesi (*The Diffusion of Management Accounting Practices*) [115], Sherif (*Total Quality Management and Construction Project Management*) [113], Mohamed (*Quality maintenance*) [53].

#### **4.3.6.1.3 Lack of knowledge and awareness about six sigma**

The table also shows that most interviewees have a lack of knowledge and awareness about six sigma. Although they said that they have heard of it, when they were asked in more detail about its concept, principles, methodology, benefits, successful factors and other features, it became clear that they have a lack of knowledge and poor understanding of six sigma. They attributed this to different reasons, for instance; “top management responsibility”, “six sigma is not widely well known in Libya”, “six sigma is not taught as course module in Libyan educational institutions”, “lack of six sigma training”, “lack of awareness, no seminars and conferences about six sigma”. Consequently, lack of knowledge and awareness about six sigma can also be considered one of the barriers that impede the adoption of six sigma in LMCs. This finding is also consistent with other studies in six sigma; Antony et al. [30], Buch & Tolentino [86], Chakrabarty & Tan [32, 87], Feng & Manuel [88], Gamal[89], Kumar et al. [31, 90], Raghunath & Jayathirtha [33], found that lack of knowledge about six sigma is a barrier to six sigma adoption, and the finding is also consistent with other studies related to LMCs but in different subject areas such as; Rahman et al. ( *Barriers and Benefits of Total Quality Management*) [116], Leftesi (*The Diffusion of Management Accounting Practices*) [115], Sherif (*Total Quality Management and Construction Project Management*) [113], found that lack of knowledge and awareness to advanced techniques one of the barriers in LMCs.

#### **4.3.6.1.4 Culture effect (Resistance to change)**

The barrier of culture effect (resistance to change) was also highlighted as one of the barriers that face LMCs in the adoption of six sigma. Interviewees said, people in LMCs at different levels refuse to accept any management or processes change, because they believe that this change will threaten their positions, their jobs, or they just want to avoid undertaking more responsibilities because they think this change will lead to an increase in workload, processes that are too complicated, bureaucracy, and some people just do not have a desire to change

from the existing system. This resistance is sometimes attributed to the lack of knowledge and awareness about the benefits and advantages of the change. This outcome is also found by; Antony et al. [30], Feng & Manuel [88], Gamal [89], Kokkranikal et al. [34], Kundi [35], Mallick et al. [97], Sarkar & Acharya [99], Raghunath & Jayathirtha [33], Taner et al. [101], found that resistance to change is a barrier to six sigma adoption, as well as by other studies related to LMCs but in different subject areas such as; Rahman et al. (*Barriers and Benefits of Total Quality Management*) [116], Sharif (*Quality Management system*) [55], Sherif (*Total Quality Management and Construction Project Management*) [113], Al-Mijrab (*Difficulties Affecting the Adoption of ISO 9000*) [114].

### **LNCSM Interview**

The researcher conducted a special interview with the former quality manager of LNCSM. By Libyan law number 5/1990, it is the responsibility and the mission of LNCSM to develop and run effective quality programmes, beside standardisation and metrology, at the national level. They also should advise, promote, encourage, help and support the Libyan companies to adopt quality programmes. The researcher asked the interviewee some questions about the centre's role in adopting six sigma, awareness programmes, and if they run any six sigma training programmes. The interviewee said that “ the centre issues a periodical bulletin twice a year, it covers general areas on standards, quality and metrology subjects, and it focuses more on ISO 9001 standards and the Libyan quality mark. The centre also holds an annual conference in the standardisation and quality field and all LMCs are invited to participate and attend this conference. The centre also run ISO 9001 training programmes and the participation is open to all Libyan organizations’”. Then the researcher asked a specific a question if there are any events, training or publications related to six sigma, the answer was ‘No’. Justified that “all LMCs who came to the centre for quality consultation were seeking ISO 9001 and none of them asked about six sigma. Also we do not even have six sigma specialists, that's why we are focusing more on ISO issues and also because the centre is a member in the ISO organization, so we get more support and help from them’”. From this interview, the researcher deduced the following:-

- There is a severe lack of awareness about six sigma at Libyan manufacturing companies as well as at the Libyan governmental body (LNCSM).

- There are no six sigma experts and specialists in all of the Libyan corporations including LNCSM.
- There are no training programmes held by LNCSM related to six sigma.
- There are no efforts from the government to encourage the LMCs to adopt six sigma.

#### 4.3.6.2 Factors that could enable the adoption of six sigma in LMCs (Enablers)

**Table 4.3: Factors that could enable the adoption of six sigma in LMCs (Enablers)**

Items mentioned by interviewees as enablers	Frequencies	Percentage
There is sufficient time to implement six sigma	10	100%
Heard about the term 'six sigma'	9	90%
Company's customers are not happy and satisfied	9	90%
Six sigma is not a complicated technique and we are certain about its results and benefits to our company	8	80%
There were sufficient financial resources	7	70%
Six sigma is not costly to our company	7	70%
We are not happy with the current quality technique	7	70%
There is good communication between all departments in the company	6	60%
There is interest in implementing six sigma	6	60%

The data collected from interviewees regarding the factors that could enable the adoption and implementation of six sigma are shown in table (4.3). The table shows that there are nine enablers already existing and available in LMCs to help and support the adoption of successful implementation of six sigma, starting with the most repeated factor by interviewees which is the availability of time to work on six sigma projects, where all interviewees (100%) mentioned that they have sufficient time to implement six sigma. Adequate time is required in order to acquire the necessary knowledge and skills about six sigma. It is quite hard to change the mind of employees who have been working for a long

period in a specific culture and system to accept new quality system initiatives. Therefore, the adoption of six sigma in an organisation needs a sufficient amount of time. All interviewees agreed that time will not impede the adoption of six sigma, as the unavailability of time can be a barrier to the implementation of six sigma as mentioned in the literature review by; Antony et al. [30], Buch & Tolentino [86], Chakrabarty & Tan [32, 87], Feng&Manuel [88], Gamal [89], Kokkranikal et al. [34], Taner et al. [101].

The second most mentioned factor as an enabler to six sigma adoption is that most interviewees (90%) have heard about six sigma and they are all convinced with six sigma as a quality tool to overcome their manufacturing issues. Also, most interviewees (90%) added that their customers are not happy and satisfied. This can help with encouraging LMCs to adopt six sigma, where one of the key objectives of six sigma is customer satisfaction. Moreover, most interviewees (70%) mentioned that they are not happy with their current quality system, so this can also push them towards adopting six sigma as they said that they have an interest in adopting this technique. Another important enabler most interviewees (70%) stated that six sigma is not costly to their company and they have sufficient financial resources to implement it, because when a company decides to adopt improvement ideas it will need new tools and technology which consequently require a financial commitment. So this factor plays a big role as an enabler to successful six sigma implementation, because lack of financial resources can impede the adoption of six sigma as mentioned in the literature review by; Dubey et al. [117], Antony et al. [30], Feng & Manuel [88], Gamal [89], Kokkranikal et al. [34], Kundi [35], Raghunath & Jayathirtha [33], Taner et al. [101].

Another existing enabler within LMCs is that there is good communication between all departments at most companies (60%). The existence of an effective communication system in a company is significant to keep the employees up-to-date of anything that concerns the whole company and their work in specific, and also to make sure that both top-down and bottom-up communications take place to make it easier for employees to understand the role of everyone in the way of improvement [118]. Bad communication systems can be a barrier to the implementation of six sigma as mentioned in the literature review by; Antony et al. [104], Gamal [89], Kokkranikal et al. [34], Kundi [35]. In summary, all factors are shown in table (4.3) can help and support as existing enablers to successful six sigma implementation in LMCs.

#### **4.3.7 Interview findings summary**

As discussed in the literature review in Chapter 2, there is a wide range of different barriers facing companies around the world in adopting and implementing six sigma. By using the exploratory sequential design, starting by conducting interviews to help narrow down the main reasons behind the lack of six sigma use in LMCs, only four key barriers were highlighted as being encountered by LMCs. With a percentage of difference in terms of their significance, these factors were identified, and placed in descending order according to their importance, namely:

- 1. Lack of top management commitment**
- 2. Lack of training**
- 3. Lack of awareness and knowledge about six sigma**
- 4. Culture effect (resistance to change)**

The interview findings also showed that some barriers that were found in the literature review do not face LMCs as reasons for not adopting six sigma, but they can, in fact, be considered as success factors or enablers for six sigma adoption. These factors as identified in this study are placed in descending order, namely:

- 1. There is sufficient time to implement six sigma**
- 2. Heard about the term six sigma**
- 3. Company's customers are not happy and satisfied**
- 4. Six sigma is not a complicated technique and we are certain about its results and benefits to our company**
- 5. There are sufficient financial resources**
- 6. Six sigma is not costly to our company**
- 7. We are not happy with the current quality technique**
- 8. There is good communication between all departments in the company**

In the next stage, the researcher will develop a questionnaire. The questionnaire questions will be mainly generated from the literature review, but will also take into account the main identified reasons and barriers from the interview findings as a starting point from which to design the questionnaire, using these barriers as anchor variables to be investigated. This will strengthen the questions that are only focused and detailed on the interview findings. The collected quantitative data will be statistically analysed by SPSS software to test a variety of statistics, and the correlation between the variables. Then this data will be used to develop a

framework and recommendations of six sigma to be presented to the Libyan manufacturing companies as a methodology to guide them into the right direction towards six sigma implementation.

#### **4.4 Development of the questionnaire**

In this stage, data will be obtained by using a questionnaire survey method as the main quantitative tool. The reason for choosing a questionnaire for collecting quantitative data is that it allows the researcher to obtain a large amount of data from a large number of participants within a short period of time. The questionnaire also allows participants to answer questions at a place and time that suits them; consequently, their answers may become more reasonable and truthful. This part of the study provides a description of the used method and development stages of the questionnaire used in the survey.

Questionnaires are written in many different ways to be used in many different situations and with many different data-gathering media. They are considered the most popular method of collecting data [119]. Questionnaires are just one of a range ways of getting information from people (or answers to a research problem) usually by posing direct or indirect questions [120]. A questionnaire has been defined by authors as:

*“Research tools through which people are asked to respond to the same set of questions in a predetermined order” [74]. “a widely used and useful instrument for collecting survey information providing structured, often numerical data, being able to be administered without the presence of the researcher, and often being comparatively straight forward to analyse” [121]. “A pre-formulated written set of questions to which respondents record their answers” [108].*

There are different types of questionnaires according to their method of distribution. Saunders and Thornhill [73] stated that questionnaires can be self-administered (distributed by hand to each respondent and collected later), online questionnaires (distributed and returned by e-mail), or postal questionnaires (distributed by mail), each has its own disadvantages and advantages. For this study the self-administrated questionnaire was chosen for the following reasons:-

- There is an opportunity to present the purpose of the research and clarify any ambiguity to questions to encourage the participants to give their answers truthfully.

- A questionnaire distributed by hand to each participant and then collected again can get a higher response rate.
- The selection of online questionnaires needs a knowledge of email addresses for the whole targeted sample; a case which cannot be guaranteed in LMCs.
- Postal questionnaires also cannot be guaranteed due to unreliable post services in Libya, which could result in a low response rate.

Collis and Hussey [60] advised the main techniques involved when developing a questionnaire which includes:- questionnaire design, type of questions, question development, scales used in the questionnaire, pilot test, population and sample size, response rate, test of validity and reliability. All of these matters will be discussed next in this chapter.

#### **4.4.1 Questionnaire design**

The aim of questionnaire design is to convert the research objectives into particular questions. The answers obtained from these questions should provide the researcher information for answering some or all of the research problems. A well-designed questionnaire is crucial to the success of a survey. Therefore, designing and constructing the questionnaire is one of the most important phases in the survey development processes. Kumar [122] stated that:

*“The construction of a research instrument or tool is the most important aspect of a research project because anything you say by way of findings or conclusions is based upon the type of information you collected, and the data you collected is entirely dependent upon your research instrument”.*

Improper questions, inappropriate question ordering, unsuitable scaling, or poor questionnaire format will make the survey useless and valueless. A poorly designed questionnaire can result in unacceptable survey findings and can also affect the survey response rate. In order to successfully achieve the aim of the questionnaire, there is some advice recommended by authors:- Fowler [123] and Robson [124] advised that when designing a questionnaire the following points should be considered:-

- Questions should be clear, short, specific, easy and quick to answer

- Questions should interest the participants in order to motivate them to give the required information
- Questions should not leave any ambiguity in the mind of the participants
- Questions should yield reliable and valid information
- The questionnaire should respect the privacy of participants

Sarantakos [125] stated that a well-designed questionnaire should contain three basic elements:- covering letter, instructions, and the main body. Each has a particular purpose: the covering letter aims to present and clarify the purpose of the questionnaire and the research topic. Instructions on how to complete the questionnaire and how to state preferences or answers should be provided. The main body includes the questions to be answered. This was supported by Easterby-Smith et al. [66] who said, that there are some fundamentals, which should be taken in account when designing a questionnaire; such as attaching a brief covering letter clarifying the purpose of the study. Then the questionnaire should start with instructions on how to fill it out; starting the questionnaire with easy and simple questions, classifying similar kinds of questions together. The researcher should be straight and clear regarding the extracted data needed in the study. When designing a questionnaire, what data is the question planned and intended to collect from participants is the first matter that should be considered, whereby, relevant information to the study can be obtained, and data with maximum relevance will be collected.

For this study, as the questionnaire tool was selected to be the main method of collecting quantitative data, the recommendations mentioned above were considered to be of paramount importance, because the researcher did not have enough time to make any adjustments and/or corrections to the questionnaire once it had been distributed. The questionnaire was very carefully designed with regard to structure, content, wording and format. Several points were borne in mind when the questionnaire was designed such as the language, the average length of time needed to complete the questionnaire and, the number of variables considered in the study. All questions were related to a specific point or variable in the study.

#### **4.4.2 Question type and development**

One of the crucial issues, which face a researcher when designing a questionnaire, is how to select the type of questions. Easterby-Smith et al. [66] stated that the main decision to be



taken in designing a questionnaire is linked to the type of question to be chosen and the overall layout of the questionnaire.

Questions are classified into two types: closed-ended or open-ended. A closed-ended question offers respondents a number of response choices by asking them to tick, circle, cross, etc. Whereas an open-ended question is not associated with choices, because sometimes the researcher cannot predict all the possible answers that respondents could make, therefore it is preferable to use open-ended questions, in this case, so the respondent has the opportunity to use his/her own words and is not restricted to the researcher's choices [126]. Hair et al. [67] said that closed-ended questions are usually used in quantitative surveys, are very convenient for data collection as they are easy and quick to answer, they require no writing, and they are usually easier to be coded and analysed, since the range of potential responses is limited.

Deciding and selecting the type of questions depends on the questions' content, the type of participants and their enthusiasm to take part in completing the questionnaire. It is recommended by many authors, Hair and Money [67], De Vaus [127], Cooper et al [128], to apply closed-ended questions in long questionnaires, because as mentioned earlier they are easy and quick to answer and more comfortable for respondents. Therefore, the main question type chosen for this survey was closed-ended, however, a few open-ended questions were also used in section one and two in the form of "other (please specify)".

In developing the questions, Collis and Hussey [60] advise that in order to decide what questions should be included in the questionnaire, the researcher must have a considerable amount of knowledge about his/her subject. This knowledge might be from the literature review, the preliminary interviews, and other studies that used questionnaires. Easterby-Smith et al. [66] supported this view and said:

*"Sometimes it is possible to borrow items and portions of questionnaires off other sources, especially when a lot of prior questionnaire-based research exists into concepts such as motivation or organisational climate".*

So when developing and generating the questions, the researcher took the recommendations of Easterby-Smith et al. [66] and used the studies of others in establishing the questions, especially those studies which were conducted within the same environment. Because the

researcher conducted his study within the LMCs, so he adopted and modified some questions from Mohamed [53], Sharif [55], Youssef [43], Sherif [113], Leftesi [115].

In addition, there are some questions which were mainly generated from the six sigma literature review as the main source, as shown earlier in this chapter in the interview questions list. Moreover, the researcher took the advice recommended by Saunders et al. [73] who said, ‘‘in order to effectively generate the questions of the questionnaire, the researcher should conduct preliminary interviews to get a feel of the key issues which must be taken into consideration in designing the questionnaire’’. Hence, the interview findings were highly considered in developing the questionnaire.

#### **4.4.3 Questionnaire sections**

The final version of the questionnaire (please see appendix 9) contained four sections as follows:

**Section one: General information:** - This section contains seven questions and was designed to obtain general and demographic information about participants such as age; position in the company; educational level; years of experience; the number of employees in the company, type of ownership of the company, and type of industry that the company operates in.

**Section two: Quality system and six sigma background:** -This section was concerned with identifying the level of quality systems and six sigma implementation in LMCs, and also deals with obtaining information about the participants, as well as six sigma training and measures the interest of participants in the adoption of six sigma.

**Section three: Factors impeding the adoption of six sigma:** - This section was specifically designed to achieve one of the main objectives of this research, which is to identify the reasons and barriers behind the lack of six sigma use in LMCs. The section contains fifteen factors from the literature review which represent barriers to the adoption of six sigma.

**Section four:** This section contains twenty-four items, which have an influence on the four factors that were identified from the interview stage as barriers, top management commitment, lack of six sigma training, lack of knowledge and awareness about six sigma,

and culture effect (resistance to change), to measure their influence on these factors and also to check their correlation and effect on each other.

#### **4.4.4 Questionnaire scales**

Different types of scale were used in the questionnaire, for instance, in sections one and two, the researcher asked yes/no questions and asked about particular categories such as age; position in the company; educational level; etc. A nominal scale was used, where choices of answers were given to respondents to select their preferred answer. However, in sections three and four a scale of measurement was used to measure the level of agreement or disagreement when respondents were asked to evaluate factors and items. It has been recommended that for scale of measurement, the Likert scale is one of the most common used in response to closed-ended questions as it is easy to understand, quick to answer, does not need much space, and enables a variety of statistical analysis to be applied, which is highly beneficial in this research [66, 73, 108].

For this study, the researcher used a five point Likert scale, because the smaller scales (e.g. three point scales) provide fewer choices for participants and can be too concise, whereas bigger scales (e.g. seven point scales) might confuse the participants. This was supported by Collis and Hussey [60] who said, using five-point Likert scale would overcome the issue of confusion produced by bigger scales and the narrowness caused by smaller scales. Whereas five point scales could provide different statements in a table, which do not take much space, and are easy for participants to fill as well as for the researcher to code and analyse the collected data.

#### **4.4.5 Translating the questionnaire**

The researcher was conducting and collecting data from LMCs, and the questionnaire was originally created in the English language, which is not broadly spoken in Libya. The first and official language in Libya is Arabic; although some people in LMCs do speak English, but to avoid any misunderstanding to questions, and to make participants feel more relaxed using their own language. It was agreed to translate the questionnaire into Arabic, and distribute it in both languages to give the participants the freedom to select whatever they prefer (English or Arabic version).

Malhotra and Birks [109] provided three techniques to translate a questionnaire. First, direct translation, in this technique the questionnaire is directly translated from the original language (English) to the targeted language (Arabic) by a bilingual translator. However, this

technique might result in discrepancy or mistranslation. Second, the parallel technique, in this method the questionnaire is translated from the original language (English) to the targeted language (Arabic) by a committee of translators; this committee discuss different translated versions and try to modify the translation until they agree on the final version. This method needs number of translators and could take longer time. The third technique is the back translation, in this method; the questionnaire is translated first from the original language (English) to the targeted language (Arabic) by a bilingual translator. Then the translated version is retranslated by another bi-lingual translator from the targeted language (Arabic) to the original language (English) so that any errors occurred or mistranslation can be amended.

In this study, the back translation technique was used for translating the questionnaire. In addition, the final Arabic version was also checked in terms of grammar by an Arabic language expert to ensure the clarity and comprehensibility of the final version. See appendix 10 final translated version of the questionnaire.

#### **4.4.6 Pilot study**

It is highly recommended to pilot-test a questionnaire before conducting the main survey. The purpose of the pilot study is to ensure that instructions and questions are clear and understandable, and also to avoid any potential problems there may occur in the main survey. Consequently, the pilot study will allow the researcher to identify these problems to be corrected and improved. In addition, the pilot study gives the researcher an idea of how much time the questionnaire takes to be completed. Collis and Hussey [60], Johnson and Gill [129] added the benefit of piloting-test a questionnaire enables the researcher to assess the questions (validity and likely reliability of data that will be collected).

Supporting this by Saunders et al. [73] who said *“The purpose of the pilot test is to refine the questionnaire so that respondents will have no problems in answering the questions and there will be no problems in recording the data. In addition, it will enable you to obtain some assessment of the questions validity and the likely reliability of the data that will be collected”*.

Gray [74] said that the interview schedule can be amended and improved if a particular question appeared to be ambiguous or ineffective, but in the case of a questionnaire, it is a ‘one shot’ attempt of collecting data. Therefore, it is vitally important to ensure that the instrument’s content is clear, understandable, unambiguous and easy to complete.

Accordingly, it was wise to run a pilot study so that any confusion and ambiguity in the instrument will be improved and modified. Collis and Hussey [60], Saunders et al. [73], Sekaran [108], De Vaus [127] Said a pilot-study may involve friends, colleagues, and people from the same targeted population to obtain different insights and ideas.

In this study, the pilot study was conducted in two stages to guarantee that the questionnaire was appropriately designed and all its contents were clear. In the first stage, the first version of the questionnaire was created in English, it was carefully reviewed and revised by the researcher's supervision team, important changes and improvements were made regarding design, layout, and questions wording. The researcher then randomly circulated an English version of the questionnaire to some PhD students at Northumbria University, to gain some information and feedback on the questionnaire in terms of how much time it takes to be completed, and if there is any ambiguity related to the instructions and questions.

In the second stage, after the required amendments in the first stage were made, (see outcomes below), the questionnaire was translated into the Arabic language as explained earlier, and then 20 questionnaires were sent in both English and Arabic versions to be pilot tested in Libyan manufacturing companies. Participants from different managerial levels were randomly selected to take part in this pilot test. This stage enabled the researcher to run a small-scale trial of the research with a small number of participants to test the validity and reliability of the questions and also to make sure that instructions and questions are clear and understandable. This increases the researcher's confidence in the data collection instrument before conducting the main survey. See appendix 6&7 questionnaire pilot study stage 1&2 respectively. The attached covering letters see appendix 4&5

The outcomes of the pilot study can be concluded as follows:

- Most of the questionnaire contents were clear, understandable and easy to complete
- The average time was taken to complete the questionnaire about 15 minutes.
- In stage two, although the researcher sent the questionnaire in both languages English and Arabic, however, all participants preferred to complete the Arabic version, as it is their mother language.
- Suggestions from participants were received regarding some questions, and also the researcher got some updates therefore, modifications needed to be done as follows:

In stage one:

- Section two Q5 “ I do not know” to be added

- Section two Q6 “ I do not know” to be added
- Section three the word “affecting” to be replaced by “impeding”
- Section three factor No1 “ lack of ” to be added to “ Top management commitment”
- Section three “six sigma is too costly to your company ” to be added as a factor No 7 in the table.

In stage two:

- Section two Q1 “ I do not know” to be added
- Section two Q2 “ I do not know” to be added
- Section two Q2 “None” to be deleted
- Section two Q4 “None” to be deleted
- Section two Q3: Q3 to be removed from section two and added to section three with “unknown to us” to become “we have not heard of six sigma and it is unknown to us”.
- Section three: to add these factors to the table “Not relevant” “No reason” as number 14 &15 respectively.
- Section three Q6: to avoid recoding the factor (Q6) in SPSS, the question should be reformatted as follows “There is no good communication between all departments in the company” instead of “There is a good communication between all departments in the company”.

The final version of the questionnaire was amended according to the pilot study feedback and then was ready for distribution to LMC. Final version of the questionnaire please see appendix 9 & 10 both English and Arabic versions. The final version was also attached with the supervisor’s support letter; see appendix 11.

#### **Response rate in the pilot study**

No of questionnaires distributed = 20

No of received usable questionnaires = 14

Response rate =  $(14 / 20) * 100 = 70 \%$

#### **4.4.7 Reliability and validity of the Questionnaire in the Pilot Study**

It is very important for any research to assess the accuracy and precision of the obtained data. Assessing the accuracy and precision of the data is concerned with assessing the reliability and validity of the developed instrument. In simple words, reliability means to get the same

results if the same object was measured on different occasions by different people. Whereas validity refers to whether or not the developed instrument measures what it sets out to measure. In other words, validity means how we can be sure that we are measuring what we intended to measure and not measuring something else. Therefore, data collected must be reliable and valid.

It is essential to know that a research instrument could be reliable without essentially being valid, as the instrument could be very reliable, but it could be measuring something else completely different from what it was originally intended to measure. Besides that, the degree of validity is limited and set by the degree of reliability. Validity cannot go above a certain degree if the measure is unreliable. While, if a measure appeared to have a very good validity, hence, it must also be reliable. Consequently, reliability is a pre-condition for validity [108, 130]. Easterby-Smith et al.[66] advised that test of reliability and validity should be done at the pilot stage before the final step of data collection.

#### **4.4.7.1 Reliability**

Reliability, as mentioned earlier, refers to the ability of the instrument to provide consistent and stable results in repeated measurements [131]. Sekaran[108] said the reliability of a measure is a sign of the consistency and stability of the instrument which is free from error, so that, it confirms consistent measurement across time and across many items in the instrument. Easterby-Smith et al.[66] stated that reliability is “*A matter of stability*”; if a questionnaire instrument is consistent and stable, it is deemed to be reliable.

In this study, the researcher used one of the most popular tests of internal consistency or homogeneity of an instrument among the items, which is called Cronbach’s coefficient, or Cronbach’s alpha. The range of Cronbach’s alpha values is from zero to one, A high score of alpha value signifies that there is similarity (or homogeneity) among the items [73, 108, 132]. Authors argue about the acceptable value of Cronbach’s alpha. Hair et al.[67] and Sekaran [133] stated that a minimum score of Cronbach’s alpha to be acceptable is 0.60 or greater, if it is less it is considered to be poor. While Nunnally [134] and Sharma [135] recommended that the minimum accepted score of Cronbach’s alpha is 0.50. On the other hand, Easterby-Smith and Lowe [66] stated that for exploratory research Cronbach’s alpha of 0.6 is acceptable, whereas in social science research the acceptable Cronbach’s alpha should be 0.7 or greater.

For this pilot study, Cronbach's alpha was tested for the questionnaire instrument using SPSS software version 22. Table 4.4 shows the calculated values.

**Table 4.4: Cronbach's alpha of each Section in the Questionnaire in the Pilot Study**

Section No	No of items	No of items deleted	Cronbach's alpha
3- Factors impeding the adoption of six sigma	13	0	0.701
4-1 Factor 1: Top management commitment	6	0	0.910
4-2 Factor 2: Training courses	6	0	0.706
4-3 Factor 3: Lack of knowledge and awareness about six sigma	5	0	0.831
4-4 Factor 4: Culture effect ( resistance to change)	7	0	0.874

The table shows the Cronbach's alpha for all variables, which were above the acceptable level of 0.60. The Cronbach's alpha ranged from 0.701 to 0.910, which was considerably higher than the acceptable level.

#### **4.4.7.2 Validity**

As mentioned earlier, validity refers to whether or not the developed instrument measures what it sets out to measure. In order to meet the requirements of validity, the researcher followed the procedures advised by Malhotra and Birks [109] and Saunders et al.[73] and the following steps are undertaken in this research to assure the validity:

- ✓ A wide literature review was utilised to define and describe the questions conducted in the questionnaire. Questions were adopted or modified from related previous studies, which already had been validated; this also allowed the researcher to compare his findings with the findings of these studies.
- ✓ To meet content validity requirements, scales and measures have to be validated. Sekaran [108] advised the necessity to utilise valid and reliable scales and measures to make sure that the research is scientific and showed the importance of developed scales and measures. In this study the scales and measures were validated by following the recommended steps such as the pilot study and also by the fact that



reliability and validity of some questions were confirmed by the previous studies, they were taken from.

- ✓ The researcher is targeting to use the whole population (Libyan manufacturing companies) as the sample for this research, which increases the external validity.
- ✓ Before distributing the final questionnaire to collect data, a pilot study for the questionnaire was conducted in two stages: colleagues, and target companies. These studies judge the content and validity of the questionnaire, some comments were received; however, the content validity was established.

#### **4.4.8 Population and sample**

The research population refers to the entire group of people, elements, cases, or things that the researcher intends to study in order to collect the required data for his/her research [108]. Saunders et al. [73] defined the population as: *“The full set of cases from which a sample is taken”*.

The target population of this study is all medium and large manufacturing companies in Libya. Whereas small companies are excluded, the rationale for selecting the medium and large companies is that such companies are expected to use different quality systems and also to have the financial resources to implement quality techniques, while small companies usually depend on traditional quality systems and they do not have the sufficient financial resources to cover such techniques.

#### **4.4.9 Questionnaire distribution and collection**

The field study was conducted during the period from Jul until Sep 2016. The questionnaire was distributed together with two covering letter (see appendix 11&12) one from the department of Mechanical Engineering at Northumbria university( student’s supervisor) and another one from the researcher explaining the purpose of the questionnaire research, in order to obtain accessibility to the targeted companies and also urging respondents to complete the questionnaire to collect the required data.

Despite the security situation during that period in Libya, however, the researcher managed to reach almost all the targeted companies. What made it easier for him was that most of the targeted companies are located in Tripoli where the researcher lives. In addition, other companies, which are located in other cities and regions, the researcher, reached them either personally or by email. It is worth mentioning that the researcher sought some help from certain close colleagues and friends with distributing and collecting some questionnaires,

particularly from companies that were out the researcher's reach. This method was really successful and had a significant impact on the response rate, although most companies responded and completed the questionnaire on time, however some companies were visited, phoned and emailed many times to get their response.

#### **4.4.10 Response rate in the final study**

No of questionnaires distributed = 150

No of received usable questionnaires = 96

Response rate =  $(96 / 150) * 100 = 64 \%$

#### **4.4.11 Reliability of the Questionnaire in the final Study**

The results of the reliability analysis (Cronbach's alpha ranges) in the final questionnaire study using SPSS package version 22 are shown in the table 4.5 below:

**Table 4.5: Cronbach's alpha of each Section in the Questionnaire in the final Study**

Section No	No of items	No of items deleted	Cronbach's alpha
3- Factors impeding the adoption of six sigma	15	0	0.654
4-1 Factor 1: Top management commitment	6	0	0.829
4-2 Factor 2: Training courses	6	0	0.631
4-3 Factor3: Lack of knowledge and awareness about six sigma	5	0	0.706
4-4 Factor 4: Culture effect ( resistance to change)	7	0	0.744

Table 4.5 shows that the Cronbach's alpha value was above 0.6 in each section, which indicates the test instrument of the final study, is reliable.

#### **4.4.12 Data Analysis Techniques**

Once assuring that data are reliable and valid, an empirical analysis of quantitative data was applied by using SPSS software version 22. There are two main statistical methods that can be utilized to find out the differences between groups and techniques, to explore the relationships between variables, to conduct the data analysis; these are parametric and non-

parametric tests. Malhotra and Birks [109] stated the most important factors in deciding which to use is based on the type of data in terms of the research's objectives and the nature of data (nominal, ordinal, interval and ratio) and the distribution of data (normal versus, non-normal). Parametric tests can be applied to analyse metric data, which are measured by using interval and ratio scales, data should be normally distributed. The non-parametric methods can be applied to analyse non-metric data, which are measured by using nominal and ordinal data scales, data free distribution [60, 108]. Collis and Hussey [60] recommended three points to be considered when selecting and conducting the proper statistical technique:

1. The number of variables to be used in the analysis
2. The distribution or nature of data ,whether normally-distributed or not
3. The measurement scale of the current data (nominal, ordinal, interval or ratio).

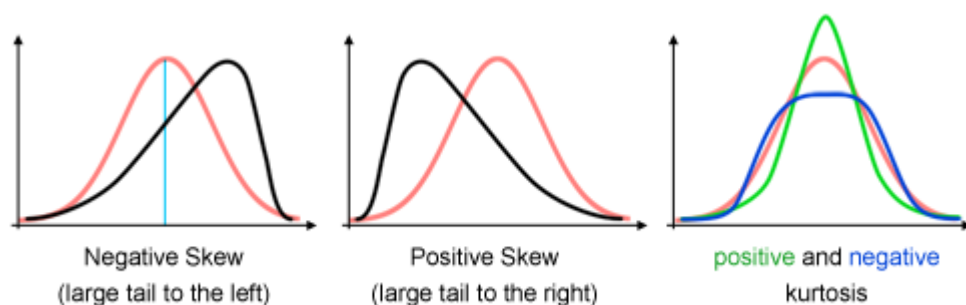
Many authors have argued about the use of parametric and non-parametric tests. Siegel and Castellan [136] and Sekaran [108] said that parametric tests can only be applied under two conditions when the scale of measurement is interval or ratio, plus the distribution of data is normal. But, if data fails to meet these conditions, the decision should be to apply non-parametric statistical tests. Non-parametric tests are data free-distribution and the measurement scale of data is ordinal or nominal. Hair et al. [67] however, explained that in business research, it is appropriate to treat the ordinal scale data as if it were interval. Hence, in this study non-parametric statistical tests were used to conduct the data analysis. The rationale for using these statistical tests is that, data were measured as ordinal on a Likert scale and also some data failed to be normally distributed. More detailed explanations about this will be presented in the following chapter.

Given below are the clarifications and justifications for each statistical technique that was used in analysing the data.

- 1- Descriptive analysis: - This was selected because it helps to analyse and interpret single variables and rank the measured variables within each construct, and it describes the current demographic information. In other meaning, descriptive analysis means raw data will be transformed into a form that provides information to describe and/or compare a set of variables (e.g. age, position occupied by respondent, number of employees in the company, years of experience, type of industry, type of implemented quality initiative, six sigma background and interest) of each respondent. The frequencies procedure offers

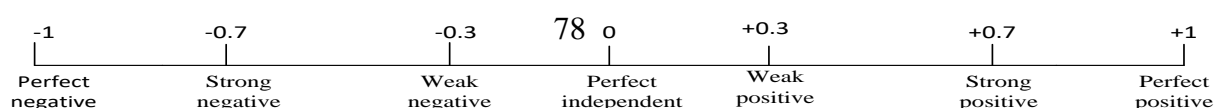
statistics and graphical displays that are helpful for describing the variables. For a frequency report and bar chart, the researcher can display values in descending or ascending order, or order the categories by their frequencies and percentage. Since the demographic questions were measured by using the nominal scale (section 1&2), the researcher used different techniques such as frequency scores and percentages [38, 89, 95, 102, 104].

- 2- Skewness and kurtosis: - Skewness is a measure of symmetry or the lack of symmetry of a distribution. A distribution, or data set, is symmetric if it appears the same to the right and left of the centre point. Kurtosis is a measure of whether the data are light-tailed or heavy-tailed relative to a normal distribution. Data set with low kurtosis tend to have light tails, or lack of outliers. Data set with high kurtosis tend to have heavy tails, or outliers. Values of skewness and kurtosis are used to check and test the normality of variables. Normality indicates to the degree of which the distribution of sample data corresponds to a normal distribution [67]. When the skewness value is greater than +1 or smaller than -1 this indicates a significantly skewed distribution. A positive skewed distribution has comparatively few large values and tails off to the right, whereas, a negative skewed distribution has comparatively few small values and tails off to the left, see figure 4.2. Hence, skewness value within the range of -1 to +1, and kurtosis value within the range of -3 to +3 indicates an acceptable range. Positive kurtosis is linked with distributions having tall, thin tail; while, negative kurtosis is linked with shorter, fatter tail comparative to the normal curve as shown in figure 4.2. In conclusion, Skewness value within the range of -1 to +1 and Kurtosis value within -3 to +3 indicates an acceptable rate for normality, while values outside the range of Skewness and kurtosis indicate an ample exit from a normal distribution. The histogram is an ideal graphical technique for displaying both the skewness and kurtosis of data set [137].



**Figure 4.2 Skewness and Kurtosis** (Red curve shows the normal distribution)

- 3- The respondents were asked in section three of the questionnaire to rate the reasons and barriers for not implementing six sigma in their companies (the respondents were asked to rate on Likert scale of 1 to 5); the results were based on the mean average score ranked from higher to lower. Standard deviation was indicated to establish the extent to which the values for a variable differ from the Mean. This was also used in section four [32, 35, 89, 95, 102, 104].
- 4- The Kruskal-Wallis test was utilised to measure the organisational parameters for six sigma barriers. This test measures the effect of a number of organisational parameters on the identified barriers. In other words, this test will check if there is a significant difference between the companies in terms of their organisational parameters such as industry type, the size of the company, ownership type, etc. on six sigma barriers. For example, will there be a significant difference between medium companies and large companies, will a company's size have an effect on barriers or not, or will they have the same barriers? [38, 89, 116]. This test is based on the value of ( $p - level$ ), statistical significance ( $p - level$ ) refers to the degree of difference or association being tested. If the observed significance level ( $p$  value) is small enough, usually less than 0.05, the null hypothesis  $H_0$  is rejected [67, 73].
- 5- Correlation analysis will be used to check if there is a relationship between two variables and to describe the strength and direction of this relationship. This test is based on the value of ( $p - level$ ), statistical significance, if ( $p \leq 0.05$ ) means that there is a relationship between the two variables. Another resulting statistic, called a correlation coefficient represented by ( $r$ ), is used to describe the strength and direction of the relationship, since it produces a number between (-1 and +1); a correlation of -1 or +1, indicates a perfect correlation, negative or positive respectively between two variables. If the correlation coefficient ( $r$ ) is equal to zero, it means there is no relationship between variables, so that they are perfectly independent [67, 73, 89, 126]. Figure 4.2 shows the strength of the relationship according to the values of correlation coefficient ( $r$ )



**Figure 4.3: Values of correlation coefficient ( $r$ ) [73]**

The Correlation test will be used to check the correlation between the six sigma barriers and to measure the relationships between each other.

## **Chapter Five**

### **5 Data Analysis and Findings**

#### **5.0 Introduction**

After presenting and outlining data collection methods and preliminary screening processes of data in the previous chapter. This chapter presents the data analysis and the results obtained from the questionnaire survey to explore the findings according to the research objectives, which are mainly concerned with identifying the reasons and barriers behind the lack of six sigma implementation in LMCs. Utilizing SPSS version 22, general information about respondents and their companies (age, position, educational level, experience, company size, ownership type, type of industry, quality system and six sigma background) were analysed using basic descriptive statistics such as frequency, percentages, and sum, providing an overview and image about respondent's characteristics and their companies. This was followed by Mean score tests to explore the reasons and barriers impeding six sigma implementation in LMCs. After exploring these barriers, a more in-depth analysis related to the barriers was carried out utilizing the Kruskal-Wallis test to check if there were any significant differences between the companies in terms of their organisational parameters such as (industry type, the size of the company, ownership type, etc.) on six sigma barriers. Then factors influencing the six sigma barriers were identified and ranked followed by correlation analysis to check and measure the correlation between six sigma barriers.

## 5.1 General information

The first section in the questionnaire (section one) was intended to gather general information about respondents such as age, position occupied by respondent, educational level, years of experience, company size, and type of industry.

### 5.1.1 Respondents' age

Figure 5.1 shows that highest ratio of respondents 39.58 % were aged between 40-49 years, they represent different levels of positions, see table 5.1. Followed by the ones who were aged 50 years and over, they represented about 34.38 %, most of them were middle managers; this indicates that most respondents have potential experience. Then 21.88% for respondents aged 30-39 years were operators, supervisors and middle managers, while the youngest respondents who were aged between 20-29 years were the smallest group, representing only 4.17%. Table 5.1 shows the distribution of age against position for the whole sample.

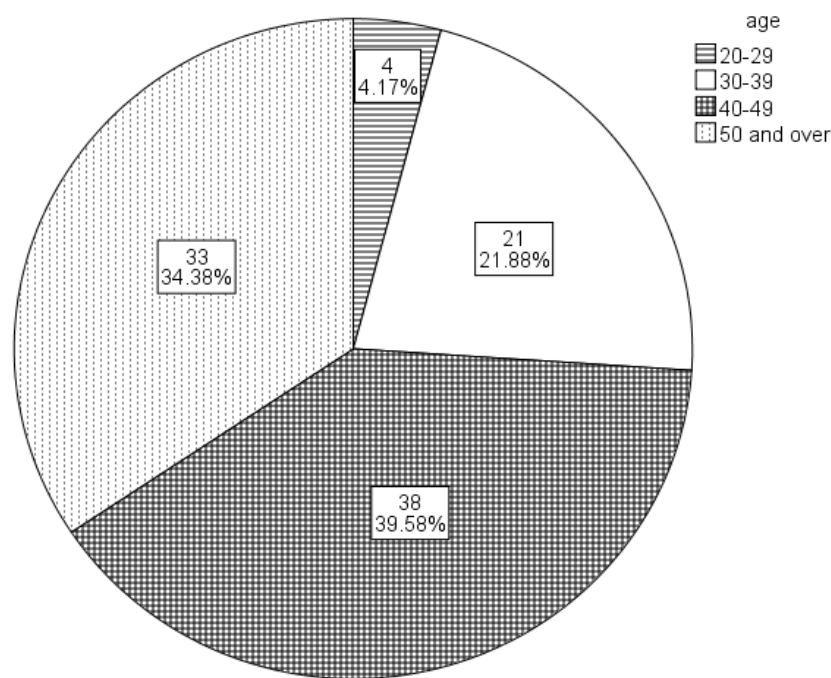


Figure 5.1: Distribution of respondents' age

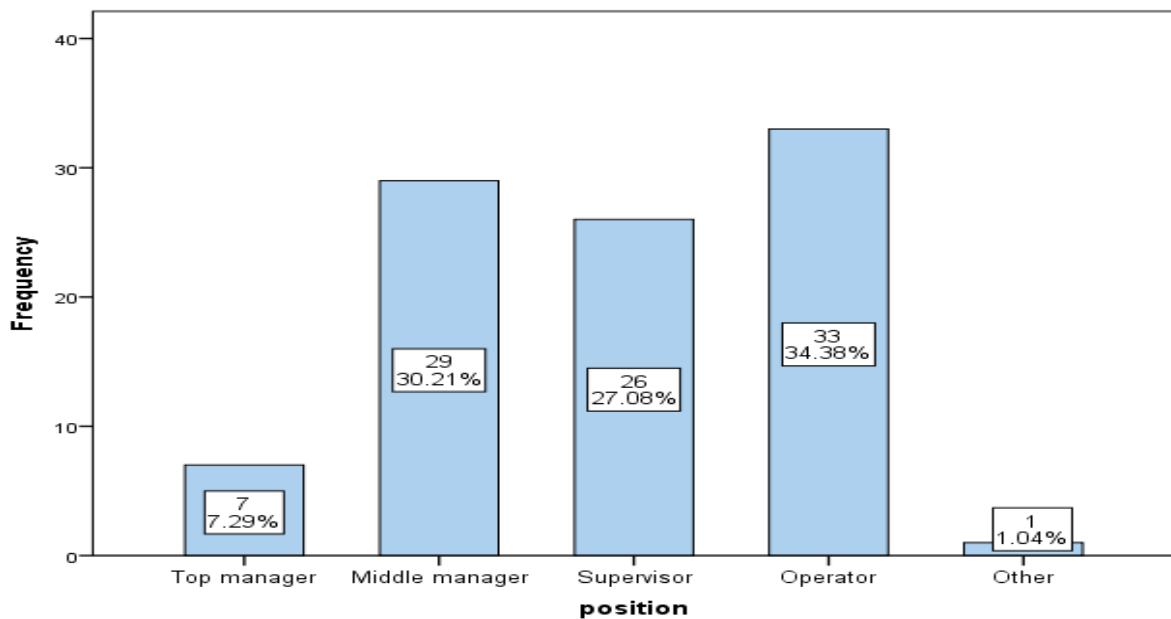
Table 5.1: Distribution of age against position

	position	Total
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		Top manager	Middle manager	Supervisor	Operator	Other	
age	20-29	1	0	1	2	0	4
	30-39	0	6	5	10	0	21
	40-49	1	8	12	17	0	38
	50 and over	5	15	8	4	1	33
Total		7	29	26	33	1	96

### 5.1.2 Respondents' position (job title) in the company

Figure 5.2 shows a good mix of the different position categories from manufacturing companies who participated in the survey. A higher ratio of 34.38 % were operators, 30.21 % were middle managers, then 27.08 % were from the supervisory level, 7.29 % were top managers, and only one participant was working as a consultant

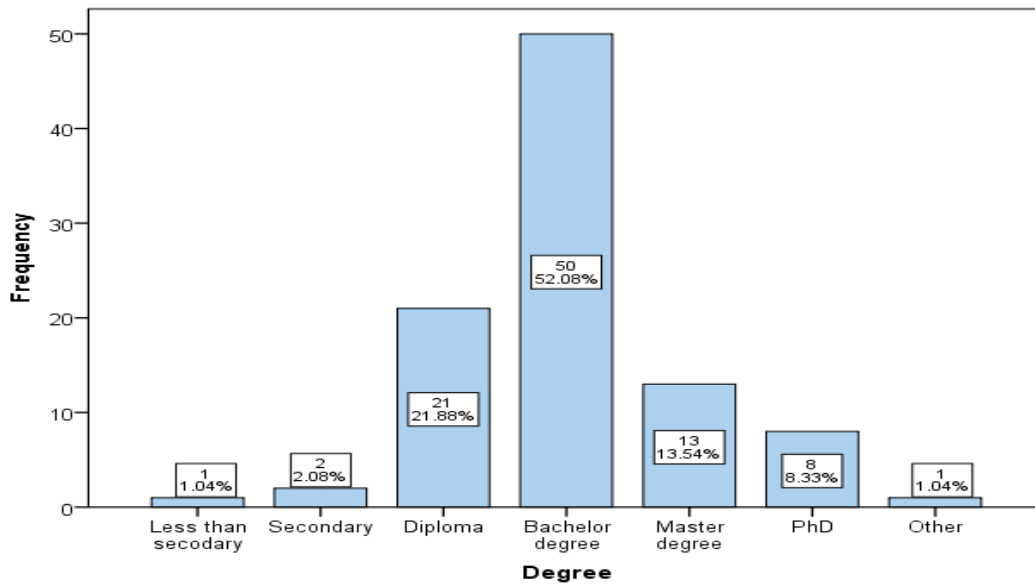


**Figure 5.2: Distribution of respondents' position**

### 5.1.3 Respondents' educational level

Figure 5.3 shows that the majority of respondents were well-educated, with more than 50% holding a bachelor degree, and 22.91% had a postgraduate qualification (e.g. MSc, Ph.D.) However, generally, it can be seen that the majority about 96%, had a diploma degree or above. It is worth mentioning that one respondent checked other without specifying what was exactly. These findings reveal that most respondents achieved a reasonable level of education, and hence, they were capable of discussing their problems and providing clear opinion and information.

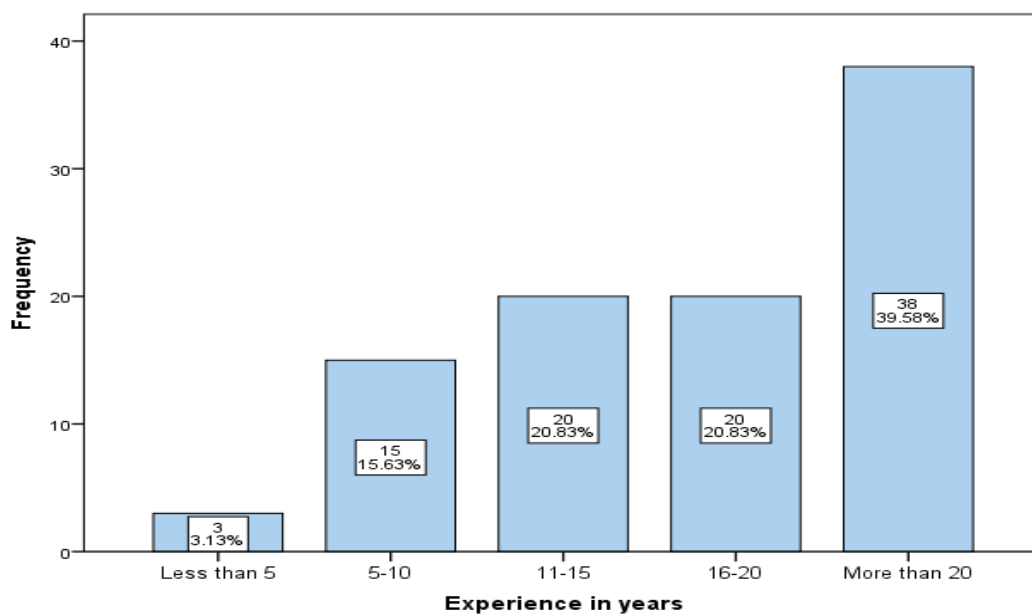




**Figure 5.3: Distribution of respondents' educational level**

#### 5.1.4 Respondents' experience

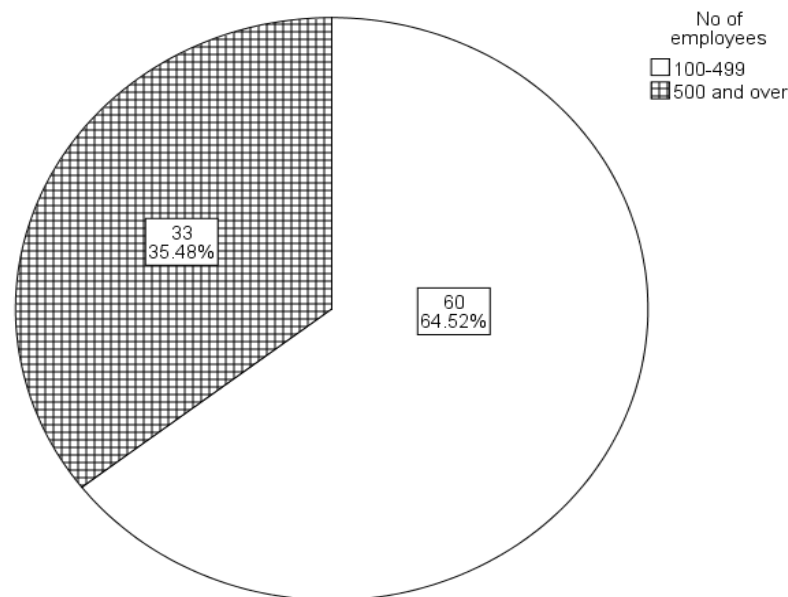
Years of experience of respondents is considered one of the most important factors in providing high quality information. Figure 5.4 shows that most respondents about 60% had an experience of more than 16 years; this should enable them to provide sufficient and accurate information. The figure also shows that 20.83% of respondents had an experience for 11 -15 years, and 15.63% had an experience between 5-10 years while only 3.13 % worked for less than five years.



**Figure 5.4: Respondents' experience**

### 5.1.5 Number of employees in the company (company size)

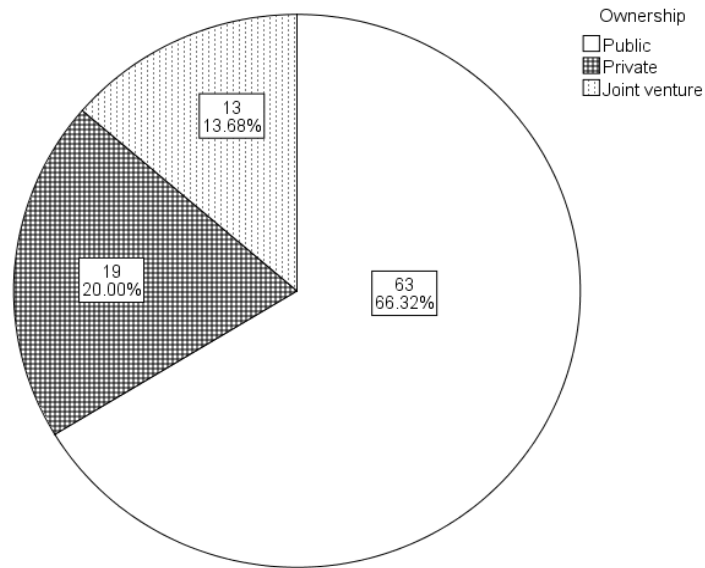
This section indicates the number of employees in the company to specify the company's size. As mentioned in chapter two section 2.2.6, a company with equal or more than 500 employees is considered 'large', a company with 100-499 employees is considered 'medium', and a company with less than 100 employees is considered 'small' [49]. Also the targeted population of this study is only medium and large manufacturing companies; this was justified in chapter four, section 4.4.8. Figure 5.5 shows that all respondents were from the targeted population of Medium and Large size companies with value of 64.52% and 35.48 % respectively.



**Figure 5.5: Company's number of employees**

### 5.1.6 Type of ownership of the company

The type of ownership is shown in figure 5.6, displaying that 66.32% of the responding companies were public (state-owned), 20.00 % of them were private companies, and 13.68 % were joint venture. This confirms what was mentioned in chapter two, section 2.2.6, that most manufacturing companies are owned by the state, particularly the large ones. See table 5.2 for more details. Hence, this mix of ownership type of the responding companies is suitable and represents a good sample to accomplish the objectives of this research in terms of age and size as well as representing a variety of ownership types.



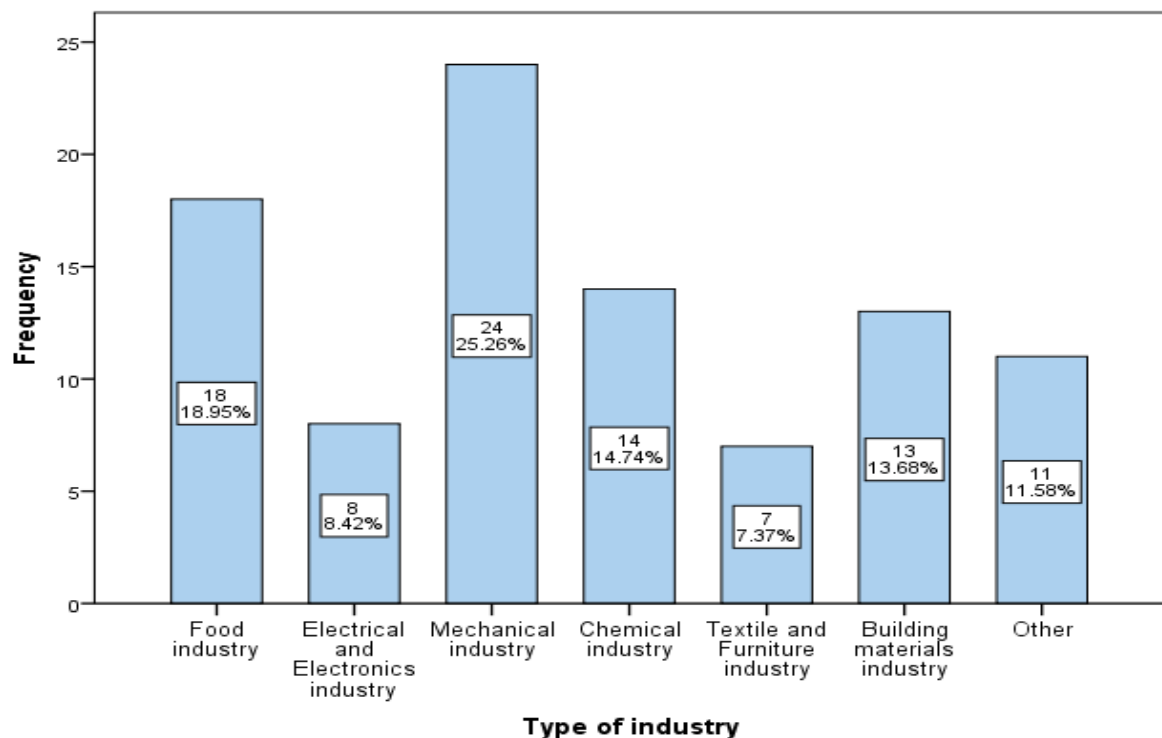
**Figure 5.6: Company type of ownership**

**Table 5.2: Distribution of number of employees against ownership**

		Ownership			Total
		Public	Private	Joint venture	
No of employees	100-499	38	12	10	60
	500 and over	23	7	2	32
Total		61	19	12	92

### 5.1.7 Company's type of industry

Figure 5.7 represents the type of industry of the responding companies, showing a wide range of manufacturing types. The highest value of 25.26 % is from the mechanical industry



followed by 18.95 % for the food industry, 14.74 % were from chemical industry, 13.68 % building materials industry, 11.58 % for other industries which unfortunately was not exactly specified by the respondents and they only checked other, then 8.42 % electrical and electronics industry, and 7.37 % textiles and furniture industry. This ensured that data was collected from various categories and also from a wide range of different respondents' opinion. It is also believed that the full manufacturing base in Libyan industry has been well covered.

## 5.2 Quality management and six sigma background

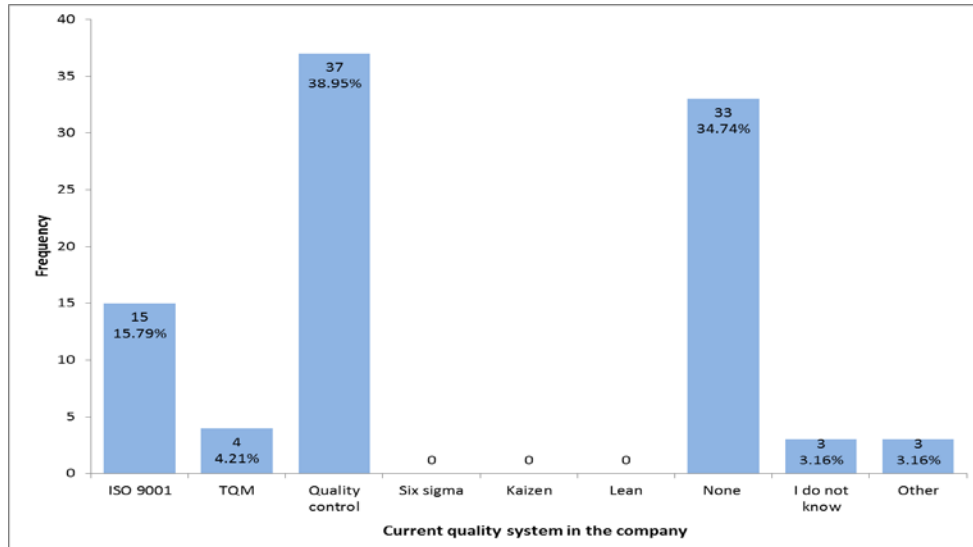
The second section in the questionnaire (Section two) was designed to gather information about current and previous quality systems in the companies, quality training, willing and interest in six sigma training and adoption, and responsibility for six sigma introduction to the company.

### 5.2.1 Current quality systems in the company

This section was specifically designed to investigate if any of Libyan manufacturing companies are currently implementing six sigma as a quality approach, and also to confirm the previous interview results and the researcher's earlier statement *“To date there is no evidence of the adoption of six sigma in the Libyan manufacturing industry”*. In addition to know what quality management techniques are currently implemented in Libyan manufacturing companies, the respondents were asked to tick the current quality system implemented in their companies, options given were (ISO 9001; TQM; Quality control; Six

**Figure 5.7: Company's type of industry**

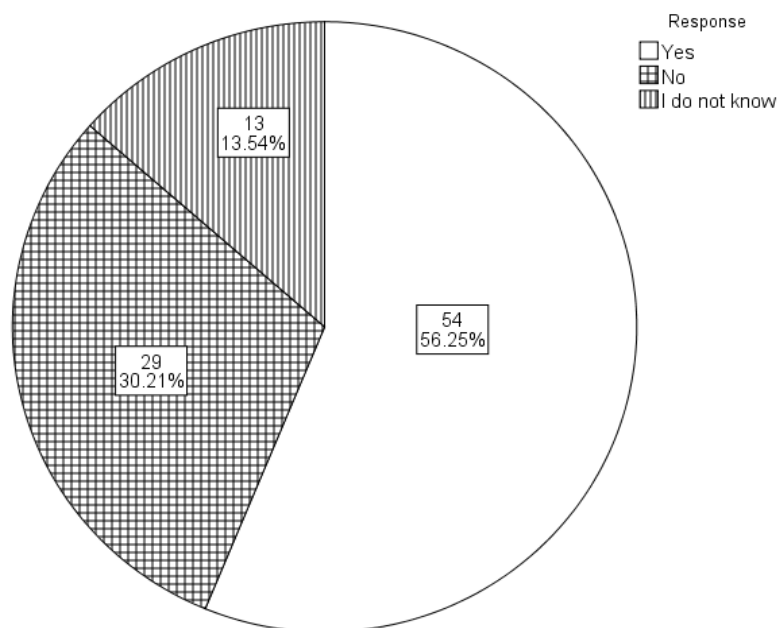
sigma; Kaizen; Lean manufacturing; None; Other, please specify.....). Figure 5.8 shows that *none of the Libyan manufacturing companies is currently implementing six sigma*. However, the figure also shows that quality control is the most common technique in LMCs with a value of 38.95%, followed by 15.79% of the sample of companies who use ISO 9001, and then 4.21% for TQM. It can also clearly be seen that a high ratio of 34.74% of the surveyed companies have no quality system implemented. These figures confirm what the researcher mentioned in chapter two, section 2.2.6.3, that LMCs suffer from a lack of implementing modern quality management systems and contemporary techniques and tools such as six sigma.



**Figure 5.8: Current quality systems in the companies**

### 5.2.2 Previously implemented quality systems in the companies

This question was intended to check if any of LMCs had previously implemented six sigma or *If a company had previously implemented any kind of quality system*. First, respondents were asked if their company had previously implemented any kind of quality system, and they were requested to tick (Yes ☐ No ☐ I do not know ☐). Figure 5.9 shows that 56.25% of respondents said “Yes”, 30.21% said “No”, and 13.54 % said “Do not know”.



**Figure 5.9: Companies that had previously implemented a quality system**

### 5.2.2.1 Type of quality system previously implemented

To check what kind of quality system was previously implemented and whether or not six sigma was among them, respondents who said “Yes” were asked to tick what kind of quality system their company had previously implemented. Options given were ISO 9001 ☐ TQM ☐ Quality control ☐ Six sigma ☐ Kaizen ☐ Lean manufacturing ☐ Other ☐, (please specify). Figure 5.10 reveals that 44.64 % of companies implemented ISO 9001, followed by quality control 41.07%, then TQM 3.57%. It is worth also mentioning here that some respondents checked “Other” without specifying. It can be noticed that none of LMCs previously implemented six sigma. Consequently, from this question and the previous question it can be confirmed that *none of the LMCs surveyed had ever implemented six sigma*.

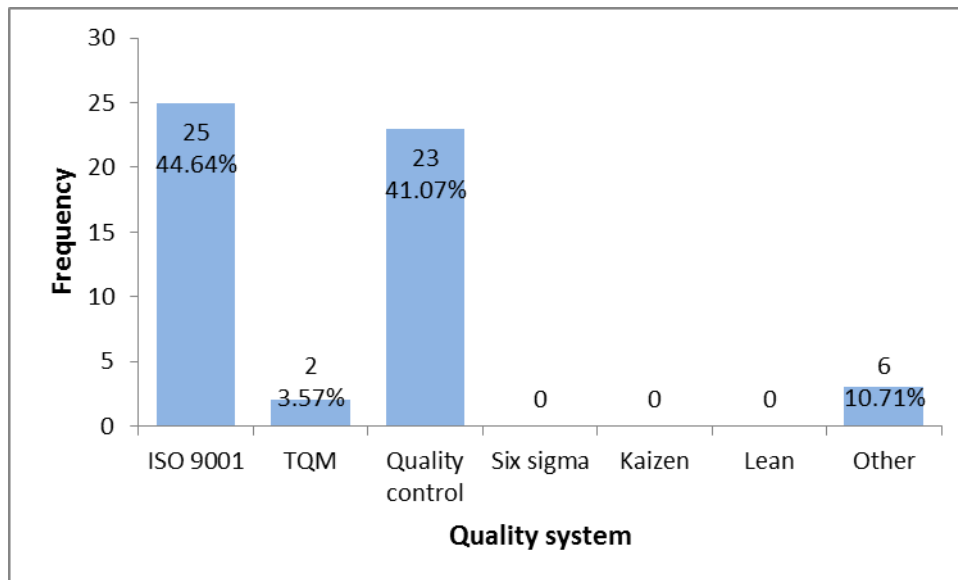
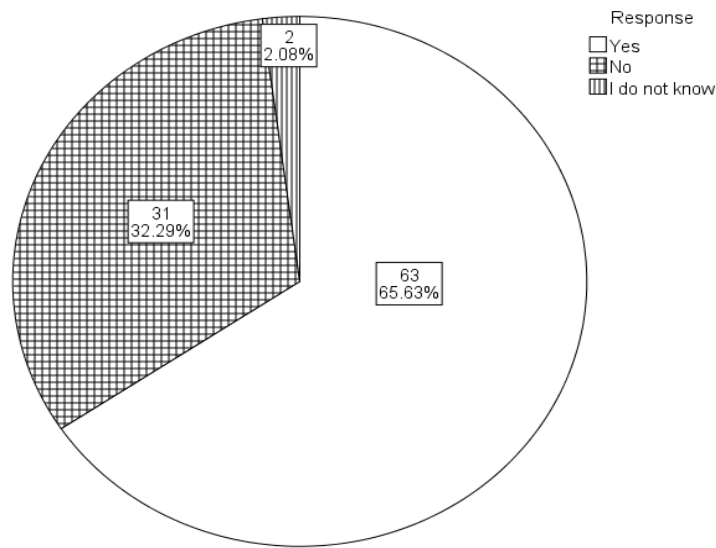


Figure 5.10: Type of quality system previously implemented

## 5.2.3 Quality training in the company

### 5.2.3.1 Whether or not a company runs quality training for employees

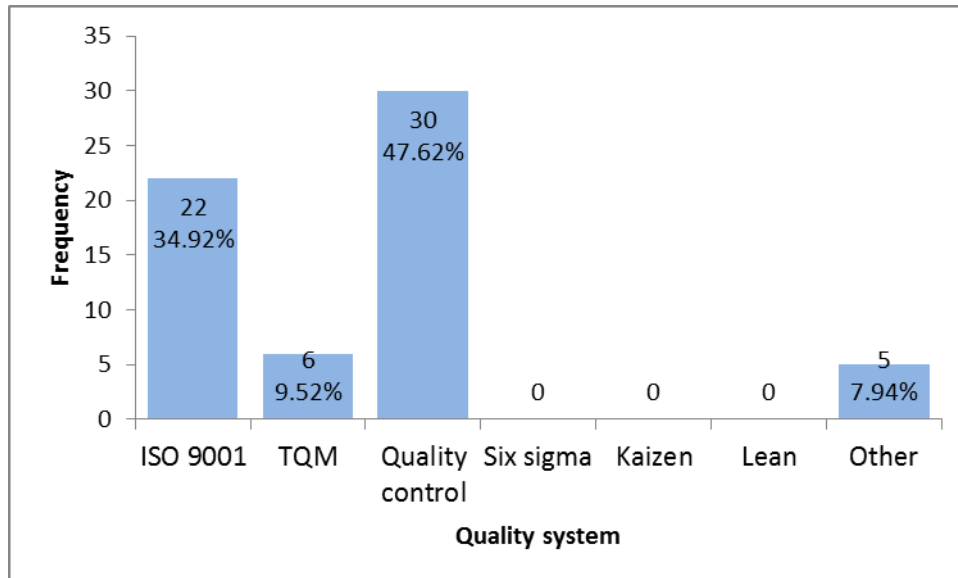
This question was designed to check and identify if LMCs run quality training for employees, as the lack of running different quality programmes could be one of the issues that LMCs suffer from. Respondents were asked to tick (Yes ☐ No ☐ I do not know ☐) if their company run any kind of quality training. Figure 5.11 shows that 65.63% of respondents said “Yes”, 32.29% said “No”, and 2.08 % said “Do not know”.



**Figure 5.11: Company runs quality training**

#### **5.2.3.2 Type of quality training**

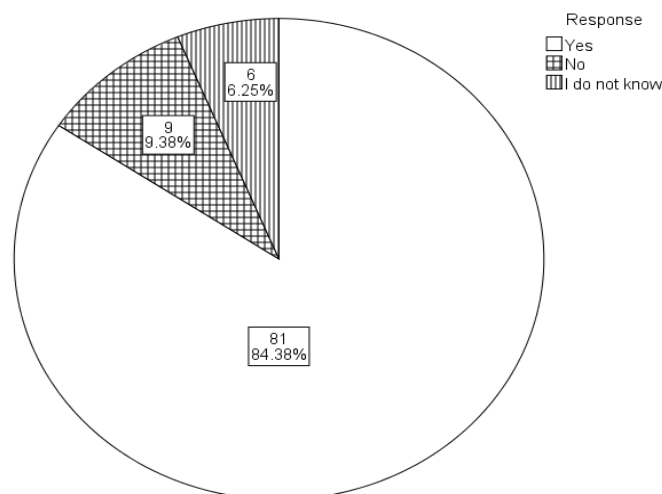
Investigation to the previous question went further, respondents who said “Yes” were asked to tick what kind of training their companies run. Options given were (ISO 9001; TQM; Quality control; Six sigma; Kaizen; Lean manufacturing; Other, please specify.....). Figure 5.12 shows that 47.62 % of them run quality control training and that reflects the fact that quality control is the most used technique in LMCs, followed by ISO 9001 training, which represents 34.92% (22 companies). It can be noticed that the number of companies that run ISO 9001 training is bigger than the number of companies that have implemented ISO 9001( 15), when the researcher probed more, he realized that there were some companies that are preparing to obtain the ISO 9001, so they have already started ISO training. However, none of the companies run six sigma training or are even planning to, this supports the LNCSM interviewee who said “all LMCs who came to us for quality consultation were seeking ISO 9001 and none of them sought for six sigma”. The figure also shows that 9.52 % of the surveyed companies run TQM training and 7.94 % of them run some other quality training. These figures reflect and show that LMCs mainly run training programmes for the same quality techniques that have been implemented.



**Figure 5.12: Type of quality training**

#### 5.2.4 Interest in six sigma training

Respondents in this question were asked if they would be interested in taking part in a six sigma training course if they had the chance. The purpose of this question is to check and assess the interest of respondents in accepting the six sigma technique. Options were offered to tick (Yes ☐ No ☐ I do not know ☐ ). Figure 5.13 shows that 84.38% of respondents were interested in joining a six sigma training course, 9.38 % said “No”, and 6.25 % said “Do not know”. These figures indicate that LMCs initially have an interest in six sigma. That motivates the researcher and gives him confidence about introducing a six sigma framework to LMCs.

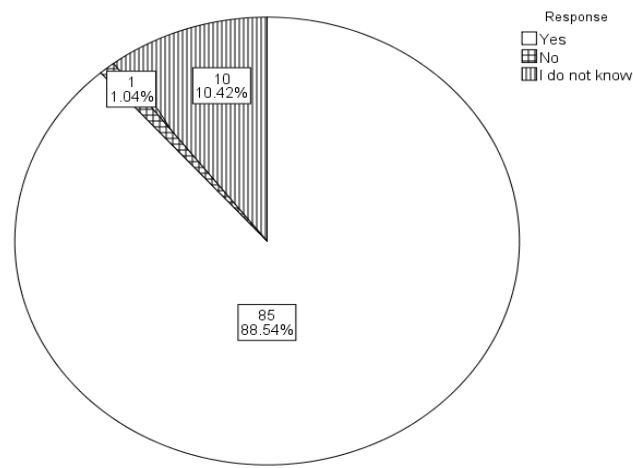


**Figure 5.13: Respondent's interest in six sigma training**



### 5.2.5 Interest in six sigma implementation

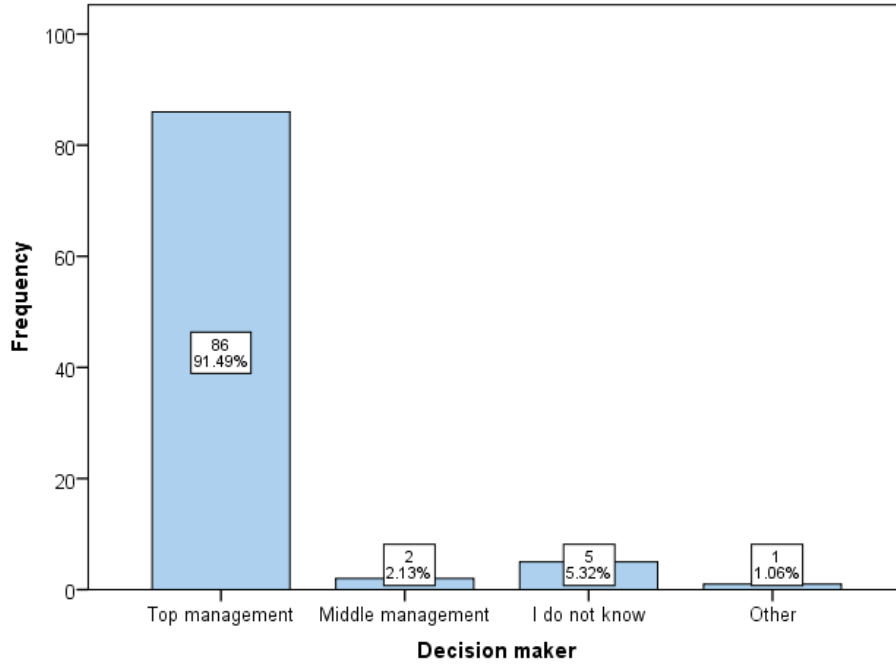
Similar to the previous question, the researcher went further asking respondents if they wish that their companies would implement six sigma in the short term. The findings of this question were almost similar to the previous one as shown in figure 5.14. 88.54 % of the respondents said “Yes” they wish that their company implement six sigma, and only 1.04% said “No”, where 10.42 % said “Do not know”. These findings give the researcher more confidence that LMCs are interested in implementing the six sigma technique once they have the opportunity.



**Figure 5.14: Respondent's interest in six sigma implementation**

### 5.2.6 Decision maker to introducing six sigma to a company

In this question, the researcher asked respondents about the responsibility of introducing six sigma to the company, in other words, who is the decision maker for introducing six sigma to the company. The purpose of this question is to check and confirm the interview results where it has found that top management commitment is a barrier to six sigma adoption and it is also important for the researcher to know the responsible people for introducing six sigma to the company to deal with them in the future when introducing the framework. Figure 5.15 shows that 91.49% of respondents said “Top management”, 5.32% said “Do not know”, 2.13 % said “Middle management”, and only 1.06 % said “other”. These figures confirm the interview findings of top management's commitment and also direct the researcher to whom he should deal with to introduce six sigma.



**Figure 5.15: Decision maker to introducing six sigma to a company**

### 5.3 Reasons/ Barriers for not implementing six sigma in LMCs

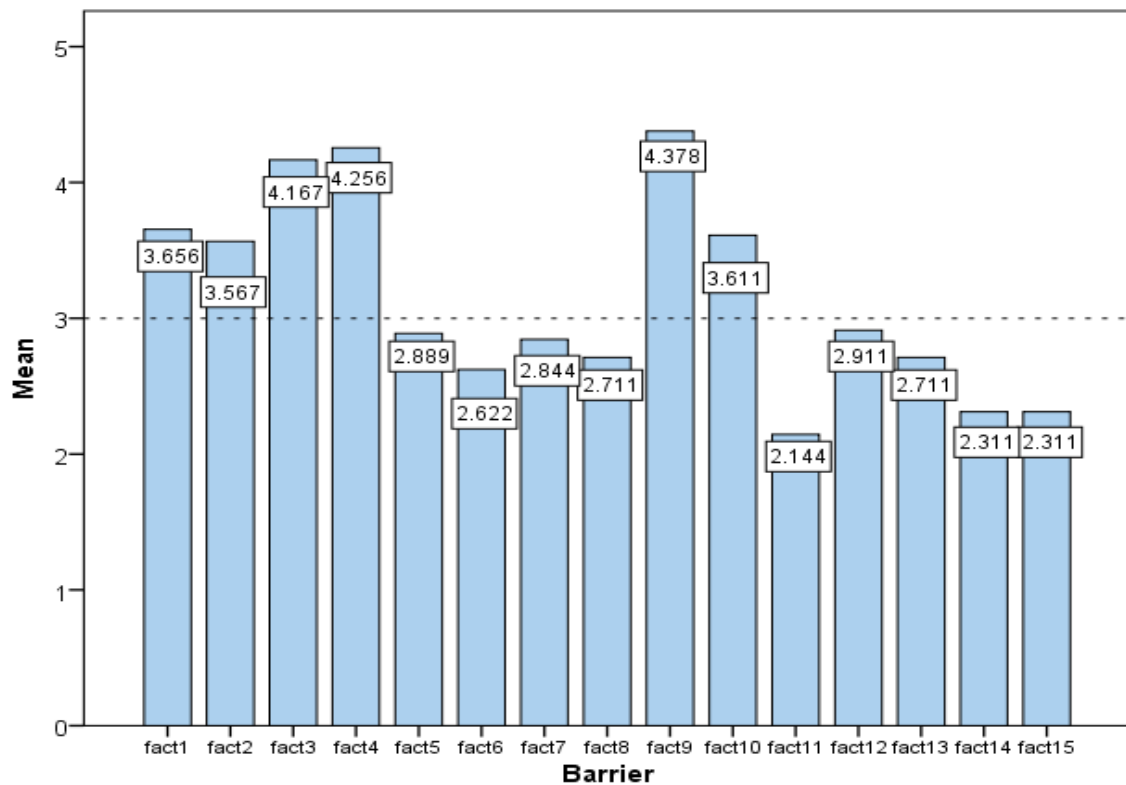
A list of fifteen factors concerning reasons and barriers impeding the adoption of six sigma were presented in section 3. Respondents were requested to rate the degree of concern on a five-point Likert scale. The average of the Likert scale is 3  $((1+2+3+4+5)/5)$ , hence, a Mean above 3 shows an agreement with the statement while a Mean below 3 shows an overall disagreement. Table 5.3 shows the results regarding the reasons/ barriers to the adoption of six sigma in LMCs.

**Table 5.3: Reasons/ Barriers for not implementing six sigma in LMCs**

Rank	Factor	Barrier / Reason	Mean	Std.Dev.	skewness	kurtosis
1	9	Lack of six sigma training courses	4.378	0.572	-0.736	0.799
2	4	Lack of six sigma expertise and specialists in our company	4.256	0.663	-1.332	3.553
3	3	Lack of knowledge and awareness about six sigma in our company	4.167	0.604	-1.828	8.192
4	1	Lack of top management commitment	3.656	0.926	-0.666	0.228
5	10	Culture effect( resistance to change)	3.611	0.956	-0.396	-0.134
6	2	We have not heard of six sigma and it is unknown to us	3.567	1.082	-0.839	-0.105
7	12	Company's customers are	2.911	0.944	-0.228	-0.235

		satisfied and happy with the quality of the products				
8	5	six sigma is a complicated technique and we are uncertain about its results and benefits	2.889	0.741	-0.105	0.901
9	7	Six sigma is too costly to our company	2.844	0.686	0.220	1.765
10	8	Lack of financial resources	2.711	1.220	0.423	-0.914
11	13	We are happy with the current quality system	2.711	0.997	0.167	-0.585
12	6	There is no good communication between all departments in the company	2.622	1.001	0.487	-0.734
13	14	Six sigma is not relevant to our work	2.311	0.870	0.259	-0.357
14	15	There is no reason	2.311	0.967	0.478	0.053
15	11	Insufficient time for implementation	2.144	0.829	0.420	-0.250

It can be seen from table 5.3, that only *six key barriers* are facing LMCs to the adoption of six sigma. With a difference in terms of their Mean average score, these barriers were identified, and placed in descending order according to their Mean score. Namely: “*Lack of six sigma training courses*” was ranked as the first barrier to six sigma adoption with a Mean of 4.378, followed by “*Lack of six sigma expertise and specialists in our company*” with a Mean of 4.256. Then “*Lack of knowledge and awareness about six sigma in our company*” with a Mean of 4.167, the forth barrier was “*Lack of top management commitment*” with a Mean score of 3.656, then “*Culture effect (resistance to change)*” and “*We have not heard of six sigma, it is unknown to us*” with a Mean score of 3.611 and 3.567 respectively. Figure 5.16 shows the distribution of all the fifteen factors around the average Mean score (3) which shows an agreement or disagreement with the statement.



**Figure 5.16: Distribution of factors around the Mean average score 3**

It can also be seen from figure 5.16 that nine factors out of fifteen were under the Mean average

score of 3, this means that respondents disagreed with these statements, in other words, these factors cannot be considered as barriers to LMCs, but they could, in fact, be considered as success factors or enablers for six sigma adoption. These factors are *“Company’s customers are satisfied and happy with the quality of the products”* with a Mean of 2.911. *“Six sigma is a complicated technique and we are uncertain about its results and benefits”* with a Mean of 2.889. *“Six sigma is too costly to our company”* Mean score 2.844. *“Lack of financial resources”* Mean score 2.711. *“We are happy with the current quality system”* Mean score 2.711. *“There is no good communication between all departments in the company”* Mean score 2.622. *“Six sigma is not relevant to our work”* Mean score 2.311. *“There is no reason”* Mean score 2.311, and then *“Insufficient time for implementation”* with Mean score of 2.144.

These findings support the previous reported interview outcomes with a slight difference in the order. The findings also achieved one of the most important objectives of this research, which is to identify the reasons and barriers behind the lack of six sigma implementation in

LMCs. Barriers were identified and were consistent with other previous studies of six sigma, which found “***Lack of six sigma training courses***” is a barrier to the adoption of six sigma. Such as Gamal [89], Kumar, M[98], Hendry [91], Kundi [35], Kwak & Anbari [96], Mallick et al. [97], Raghunath & Jayathirtha [33], Sarkar & Acharya [99], Snee [100]. The outcome is also consistent with previous studies to LMCs but in other subject areas such as Al-Mijrab (*Difficulties Affecting the Adoption of ISO 9000*) [114], Leftesi (*The Diffusion of Management Accounting Practices*) [115], Sherif (*Total Quality Management and Construction Project Management*) [113], Mohamed (*Quality maintenance*) [53], which found that lack of training programmes is one of the issues to LMCs.

“***Lack of six sigma expertise and specialists in our company***” was identified in this study as a barrier to LMCs, this outcome is consistent with Buch & Tolentino [86], Gamal [89], Hendry [91], Kwak & Anbari [96], Snee [100], Taner et al. [101] who found that lack of six sigma expertise and specialists is one of the barriers to the six sigma implementation.

“***Lack of knowledge and awareness about six sigma in our company***” was also identified in this study as a barrier to LMCs. This outcome is consistent with; Antony et al. [30], Buch & Tolentino[86], Chakrabarty & Tan [32, 87], Feng & Manuel [88], Gamal [89], Kumar et al. [31, 90], Raghunath & Jayathirtha [33]; who found that lack of knowledge about six sigma is a barrier to six sigma adoption. This finding is also consistent with other studies related to LMCs but in different subject areas such as; Rahman et al.( *Barriers and Benefits of Total Quality Management*)[116], Leftesi(*The Diffusion of Management Accounting Practices*) [115], Sherif (*Total Quality Management and Construction Project Management*) [113], who found lack of knowledge and awareness of advanced techniques to be one of the barriers in LMCs.

The forth reason for not implementing six sigma in LMCs was “***Lack of top management commitment***”, this was also identified by; Dahlgaard & Dahlgaard-Park [105], Gamal [89], Kundi [35], Mallick et al. [97], Raghunath & Jayathirtha [33], Sarkar & Acharya [99], Sehwal & DeYong [93], who found that lack of top management commitment is a barrier to six sigma adoption, and the finding is also consistent with other studies related to LMCs but in different subject areas such as Hokoma et al.(*Quality and Manufacturing Management*) [111], Arshida & Agil (*Critical Success Factors for Total Quality Management*) [112], Youssef

(*Total Quality Management*) [43], Mohamed (*Quality maintenance*) [53], Sharif (*Quality Management system*) [55], Sherif (*Total Quality Management and Construction Project Management*) [113]. “**Culture effect (resistance to change)**” came fifth as one of the barriers impeding the adoption of six sigma in LMCs. This outcome is consistent with; Antony et al. [30], Feng & Manuel [88], Gamal [89], Kokkranikal et al. [34], Kundi [35], Mallick et al. [97], Sarkar & Acharya [99], Raghunath & Jayathirtha [33], Taner et al. [101], who found that resistance to change is a barrier to six sigma adoption, as well as by other studies related to LMCs but in different subject areas such as; Rahman et al. (*Barriers and Benefits of Total Quality Management*) [116], Sharif (*Quality Management system*) [55], Sherif (*Total Quality Management and Construction Project Management*) [113], Al-Mijrab (*Difficulties Affecting the Adoption of ISO 9000*) [114].

The last reason was “**we have not heard of six sigma and it is unknown to us**” which means that some respondents had never heard of six sigma. Some other studies found the same reason such as; Antony et al. [30], Buch & Tolentino [86], Chakrabarty & Tan [32, 87], Feng & Manuel [88], Gamal [89], Kumar et al. [31, 90], Raghunath & Jayathirtha [33]. For example, Chakrabarty & Tan in their study in Singapore organizations found that 14% of the respondents said that “we have not heard of six sigma and it is unknown to us”.

### 5.3.1 Test of significant differences

Further analysis using the Kruskal-Wallis test was undertaken to determine if there were any statistically significant differences between the companies in terms of their organisational parameters, such as industry type, the size of the company, or ownership type, etc., as independent variables for six sigma barriers as dependents variables. This test was chosen to be used for the following reasons:

- 1- All dependents variable were measured as ordinal on a Likert scale.
- 2- Some dependents data were non-normally distributed as it can be seen from table 5-3 skewness of factors 3&4 was out of the range -1 to +1 and also kurtosis for these factors was also out of the range -3 to +3.

#### Note:

Dependent variable: a variable that may depend on other factors, for example six sigma barriers may change as a variable depending on a company’s parameters

Independent variable: a variable that does not depend on other factors.

### 5.3.1.1 Distribution of six sigma barriers across all categories of age

Null Hypothesis  $H_0$ : There is no significant difference between the companies for the six sigma barriers across all categories of age.

Alternative Hypothesis  $H_1$ : There is significant difference between the companies for the six sigma barriers across all categories of age.

**Table 5.4: Test of significant differences between the companies for six sigma barriers across categories of age**

Test	Null Hypothesis	Factor	Significance	Decision
Independent samples Kruskal Wallis test	The distribution of the factor is the same across all categories of age	Lack of top management commitment	0.402	Retain the null hyp.
		We have not heard of six sigma and it is unknown to us	0.781	Retain the null hyp.
		Lack of knowledge and awareness about six sigma in our company	0.823	Retain the null hyp.
		Lack of six sigma expertise and specialists in our company	0.153	Retain the null hyp.
		Lack of six sigma training courses	0.881	Retain the null hyp.
		Culture effect (resistance to change)	0.701	Retain the null hyp.
		Asymptotic significances are displayed. The significance level is 0.05		

Table 5.4 shows that there were no significant differences between companies for six sigma barriers across all categories of age, p values > 0.05.

### 5.3.1.2 Distribution of six sigma barriers across categories of position

Null Hypothesis  $H_0$ : There is no significant difference between the companies for the six sigma barriers across all categories of position.

Alternative Hypothesis  $H_1$ : There is significant difference between the companies for the six sigma barriers across all categories of position.

**Table 5.5: Test of significant differences between the companies for six sigma barriers across all categories of position**

Test	Null Hypothesis	Factor	Significance	Decision
Independent samples Kurskal Wallis test	The distribution of the factor is the same across all categories of position	Lack of top management commitment	0.836	Retain the null hyp.
		<b>We have not heard of six sigma and it is unknown to us</b>	<b>0.018</b>	<b>Reject the null hyp.</b>
		Lack of knowledge and awareness about six sigma in our company	0.122	Retain the null hyp.
		Lack of six sigma expertise and specialists in our company	0.509	Retain the null hyp.
		Lack of six sigma training courses	0.121	Retain the null hyp.
		Culture effect (resistance to change)	0.150	Retain the null hyp.
Asymptotic significances are displayed. The significance level is 0.05				

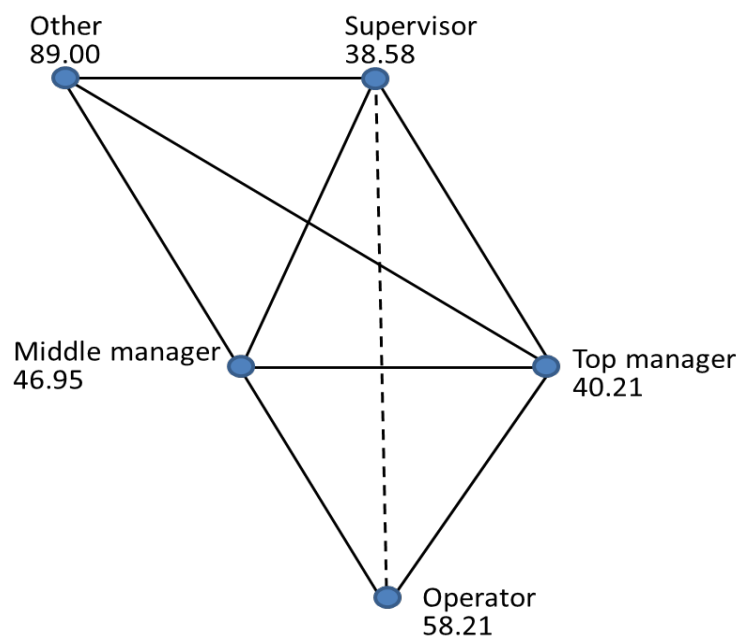
Table 5.5 shows that, there were no significant differences between companies for six sigma barriers across all categories of position, where p values > 0.05. Except factor 2 “we have not heard of six sigma and it is unknown to us” where p value < 0.05, this means that there was significant difference between companies on factor 2 across categories of position.

Further analysis using pairwise comparison of position was carried out to determine which positions have significant differences on factor 2. The following table 5.6 and figure 5.17 shows that there was significant difference between companies on factor 2 across categories of position (supervisor-employee) where p value < 0.05.

**Table 5.6: Pairwise comparison of position**



Sample1 – sample2	Test statistics	Significance
Supervisor-Top manager	1.637	0.881
Supervisor- Middle manager	8.371	0.228
<b>Supervisor- Operator</b>	<b>-19.635</b>	<b>0.004</b>
Supervisor- Other	-50.423	0.054
Top manager- Middle manager	-6.734	0.534
Top manager- Operator	-17.998	0.092
Top manager-Other	-48.786	0.076
Middle manager- Operator	-11.264	0.085
Middle manager- Other	-42.052	0.107
Operator- Other	-30.788	0.238
Each row tests the null hypothesis that the sample 1 and sample 2 distribution are the same. Asymptotic significances are displayed. The significance level is 0.05.		



**Figure 5.17: Pairwise comparison of position**

(each node shows the sample average rank of position)

### 5.3.1.3 Distribution of six sigma barriers across all categories of education

Null Hypothesis  $H_0$ : There is no significant difference between the companies for the six sigma barriers across all categories of education

Alternative Hypothesis  $H_1$ : There is significant difference between the companies for the six sigma barriers across all categories of education

**Table 5.7: Test of significant differences between the companies for six sigma barriers across all categories of education**

Test	Null Hypothesis	Factor	Significance	Decision
Independent samples Kruskal Wallis test	The distribution of the factor is the same across all categories of education	Lack of top management commitment	0.074	Retain the null hyp.
		We have not heard of six sigma and it is unknown to us	0.192	Retain the null hyp.
		Lack of knowledge and awareness about six sigma in our company	0.061	Retain the null hyp.
		Lack of six sigma expertise and specialists in our company	0.297	Retain the null hyp.
		Lack of six sigma training courses	0.114	Retain the null hyp.
		Culture effect (resistance to change)	0.326	Retain the null hyp.
Asymptotic significances are displayed. The significance level is 0.05				

Table 5.7 shows that there were no significant differences between companies for six sigma barriers across all categories of education, p values > 0.05.

#### **5.3.1.4 Distribution of six sigma barriers across categories of experience**

Null Hypothesis  $H_0$ : There is no significant difference between the companies for the six sigma barriers across all categories of experience

Alternative Hypothesis  $H_1$ : There is significant difference between the companies for the six sigma barriers across all categories of experience.

**Table 5.8: Test of significant differences between the companies for six sigma barriers across all categories of experience**

Test	Null Hypothesis	Factor	Significance	Decision
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Independent samples Kruskal Wallis test	The distribution of the factor is the same across all categories of experience	Lack of top management commitment	0.299	Retain the null hyp.
		We have not heard of six sigma and it is unknown to us	0.208	Retain the null hyp.
		Lack of knowledge and awareness about six sigma in our company	0.402	Retain the null hyp.
		<b>Lack of six sigma expertise and specialists in our company</b>	<b>0.039</b>	<b>Reject the null hyp.</b>
		Lack of six sigma training courses	0.238	Retain the null hyp.
		Culture effect (resistance to change)	0.434	Retain the null hyp.
Asymptotic significances are displayed. The significance level is 0.05				

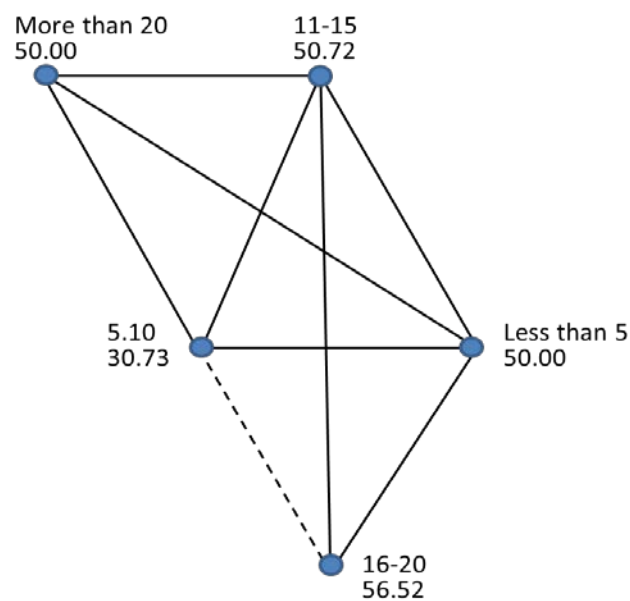
Table 5.8 shows that, there were no significant differences between companies for six sigma barriers across all categories of experience, where p values > 0.05. Except factor 4 ‘‘Lack of six sigma expertise and specialists in our company’’, where p value < 0.05, this means that there was significant difference between companies on factor 4 across categories of experience.

Further analysis pairwise comparison of experience was carried out to determine which experience categories have significant differences on factors 4. The following table 5.9 and figure 5.18 show that there was significant difference between companies on factor 4 across categories of experience (5-10 years, 16-20 years) where p value < 0.05.

**Table 5.9: Pairwise comparison of experience**

Sample1 – sample2	Test statistics	Significance
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5-10 years -Less than 5 years	19.267	0.219
5-10 years – More than 20 years	-19.267	0.108
5-10 years- 11-15 years	-19.992	0.183
5-10 years – 16-20 years	-25.792	0.002
Less than 5 years - More than 20 years	0.000	1.000
Less than 5 years - 11-15 years	-0.725	0.962
Less than 5 years -16-20 years	-6.525	0.671
More than 20 years - 11-15 years	-0.725	0.916
More than 20 years - 16-20 years	6.525	0.341
11-15 years -16-20 years	-5.800	0.460
Each row tests the null hypothesis that the sample 1 and sample 2 distribution are the same. Asymptotic significances are displayed. The significance level is 0.05.		



**Figure 5.18: Pairwise comparisons of experience**  
(each node shows the sample average rank of position)

### 5.3.1.5 Distribution of six sigma barriers across all categories of company size

Null Hypothesis  $H_0$ : There is no significant difference between the companies for the six sigma barriers across all categories of company size

Alternative Hypothesis **H<sub>1</sub>**: There is significant difference between the companies for the six sigma barriers across all categories of company size

**Table 5.10: Test of significant differences between the companies for six sigma barriers across all categories of company size**

Test	Null Hypothesis	Factor	Significance	Decision
Independent samples Kurskal Wallis test	The distribution of the factor is the same across all categories of No- of employees	Lack of top management commitment	0.623	Retain the null hyp.
		We have not heard of six sigma and it is unknown to us	0.589	Retain the null hyp.
		Lack of knowledge and awareness about six sigma in our company	0.597	Retain the null hyp.
		Lack of six sigma expertise and specialists in our company	0.068	Retain the null hyp.
		Lack of six sigma training courses	0.675	Retain the null hyp.
		Culture effect (resistance to change)	0.616	Retain the null hyp.
Asymptotic significances are displayed. The significance level is 0.05				

Table 5.10 shows that there were no significant differences between companies for six sigma barriers across all categories of company size, p values > 0.05.

#### **5.3.1.6 Distribution of six sigma barriers across categories of ownership**

Null Hypothesis **H<sub>0</sub>**: There is no significant difference between the companies for the six sigma barriers across all categories of ownership

Alternative Hypothesis **H<sub>1</sub>**: There is significant difference between the companies for the six sigma barriers across all categories of ownership

**Table 5.11: Test of significant differences between the companies for six sigma barriers across all categories of ownership**

Test	Null Hypothesis	Factor	Significance	Decision
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Independent samples Kruskal Wallis test	The distribution of the factor is the same across all categories of ownership type	Lack of top management commitment	0.032	Reject the null hyp.
		We have not heard of six sigma and it is unknown to us	0.855	Retain the null hyp.
		Lack of knowledge and awareness about six sigma in our company	0.536	Retain the null hyp.
		Lack of six sigma expertise and specialists in our company	0.437	Retain the null hyp.
		Lack of six sigma training courses	0.455	Retain the null hyp.
		Culture effect (resistance to change)	0.677	Retain the null hyp.
Asymptotic significances are displayed. The significance level is 0.05				

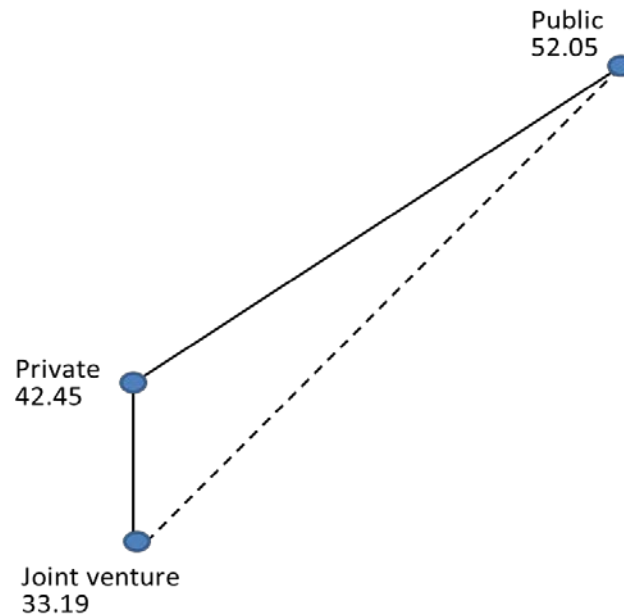
Table 5.11 shows that, there were no significant differences between companies for six sigma barriers across all categories of ownership, where p values > 0.05. Except factor 1 ‘‘Lack of top management commitment’’, where p value < 0.05, this means that there was significant difference between companies on factor 1 across categories of ownership.

Further analysis pairwise comparison of ownership was carried out to determine which ownership types have significant differences on factors 1. The following table 5.12 and figure 5.19 show that there was significant difference between companies on factor 1 across categories of ownership type (joint venture-public) where p value < 0.05.

**Table 5.12: Pairwise comparison of ownership**

<b>Sample1 – sample2</b>	<b>Test statistics</b>	<b>Significance</b>
Joint venture - Private	9.225	0.311

<b>Joint venture - Public</b>	<b>18.856</b>	<b>0.015</b>
Private - Public	9.601	0.149
Each row tests the null hypothesis that the sample 1 and sample 2 distribution are the same. Asymptotic significances are displayed. The significance level is 0.05.		



**Figure 5.19: Pairwise comparisons of ownership**

(each node shows the sample average rank of position)

### 5.3.1.7 Distribution of six sigma barriers across all categories of company- operation

Null Hypothesis  $H_0$ : There is no significant difference between the companies for the six sigma barriers across all categories of company-operation

Alternative Hypothesis  $H_1$ : There is significant difference between the companies for the six sigma barriers across all categories of company- operation

**Table 5.13: Test of significant differences between the companies for six sigma barriers across all categories of company operation**

Test	Null Hypothesis	Factor	Significance	Decision
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Independent samples Kruskal Wallis test	The distribution of the factor is the same across all categories of Company-operation	Lack of top management commitment	0.082	Retain the null hyp.
		We have not heard of six sigma and it is unknown to us	0.919	Retain the null hyp.
		Lack of knowledge and awareness about six sigma in our company	0.995	Retain the null hyp.
		Lack of six sigma expertise and specialists in our company	0.979	Retain the null hyp.
		Lack of six sigma training courses	0.342	Retain the null hyp.
		Culture effect (resistance to change)	0.521	Retain the null hyp.
		Asymptotic significances are displayed. The significance level is 0.05		

Table 5.13 shows that there were no significant differences between companies for six sigma barriers across all categories of company-operation,  $p$  values  $> 0.05$ .

In conclusion, the previous analysis clearly shows that there were only a few specific types of organizational parameters that have significant differences for six sigma barriers which were position (supervisor-employee) on the influence of six sigma barrier “we have not heard of six sigma and it is unknown to us”. Experience (5-10 years, 16-20 years) was significantly different on the six sigma barrier “Lack of six sigma expertise and specialists in our company”. Ownership type (joint venture- public) also had a significant difference the on six sigma barrier “Lack of top management commitment”. The other organizational parameters had no significant differences between companies on six sigma barriers. These findings are similar to the findings of Gamal [89] who found in his study that the organization size, ownership type, experience, and industry type had significant differences on six sigma barriers. Cheng [138, 139] found that ownership type has a significant difference on six sigma barriers. On the contrary, in this study, organization size surprisingly has insignificant difference on six sigma barriers, where other studies such as Gamal [89], Wessel & Burcher’s [140], Thakkar et al. [141], found that organization size has a significant effect on the influence of six sigma implementation barriers. This can be justified by two reasons; first, their studies were on companies that had already implemented six sigma, so that those



companies are more experienced with six sigma. Secondly the scale of the company's size might differ from one country to another, for example, a medium sized company in Libya is between 100-499 this could be a large sized company in another country. For instance, in the UK, an organization is considered an SME if it has less than 250 employees, if it has 250 employees or more it is considered as a large company as stated by Department of Trade and Industry (DTI 2006).

## 5.4 Influencing factors

Section four in the questionnaire contains twenty-four factors which have an influence on the barriers that were identified from the interview stage. These factors were ranked according to their average Mean scores. Correlation matrix analysis was carried out to check the correlation between the identified barriers and their effect on each other.

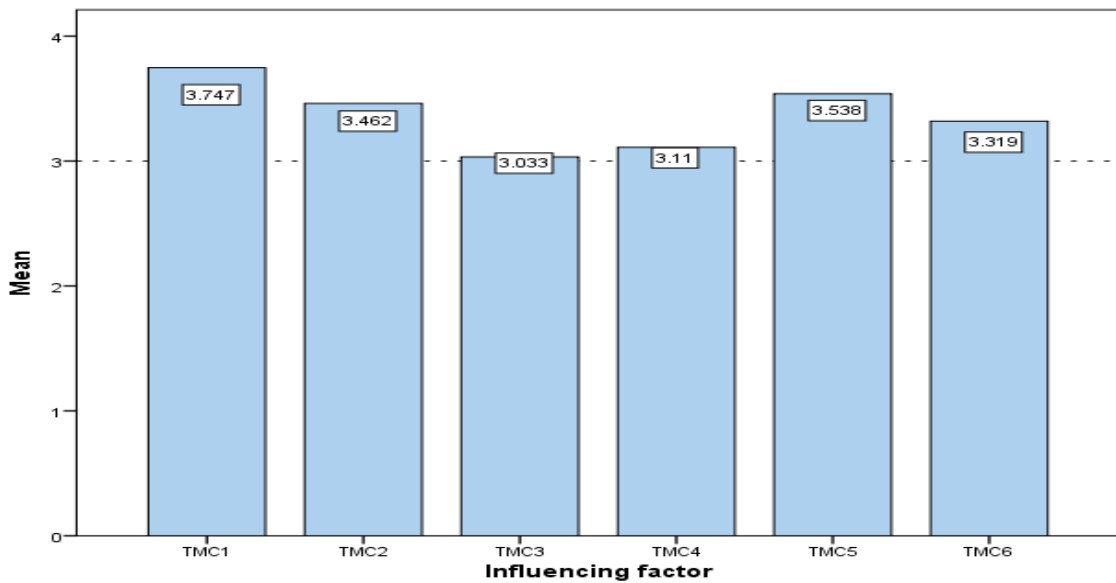
### 5.4.1 Top management commitment

This analysis was carried out to identify the reasons behind the lack of top management commitment. Six factors were presented to respondents and they were requested to rate the degree of concern on a five-point Likert scale.

**Table 5.14: Factors influencing top management commitment**

Rank		Factor	Mean	Std.Dev.
1	TMC1	Top management have a lack of knowledge about six sigma	3.747	0.970
2	TMC5	There are wrong people in the wrong positions	3.538	1.024

3	TMC2	Top management do not pay attention to introducing six sigma	3.462	1.003
4	TMC6	There is a lack of leadership and effective leaders in your company	3.319	1.122
5	TMC4	Top management do not allocate adequate resources and time for quality improvement	3.11	1.109
6	TMC3	Top management have no clear quality vision	3.033	1.196



**Figure 5.20: Factors influencing top management commitment**

From the above table 5.14 and figure 5.20. It can be seen that the factor with greatest influence on lack of top management commitment was *“Top management have a lack of knowledge about six sigma”* with a Mean score of 3.747. Then *“There are wrong people in the wrong positions”* came second with a Mean score of 3.538, followed by *“Top management do not pay attention to introducing six sigma”* with a Mean score of 3.462. The forth reason was *“There is a lack of leadership and effective leaders in your company”* with a Mean score of 3.319. The fifth was *“Top management do not allocate adequate resources and time for quality improvement”* with a Mean score of 3.11, the last reason was *“Top management have no clear quality vision”* with a Mean score of 3.033. It is worth mentioning that respondents agreed with all the six factors as the Mean scores were above 3 for each factor which means top management suffer from all of these six drawbacks. These findings are similar to the findings of other studies which were carried out on Libyan

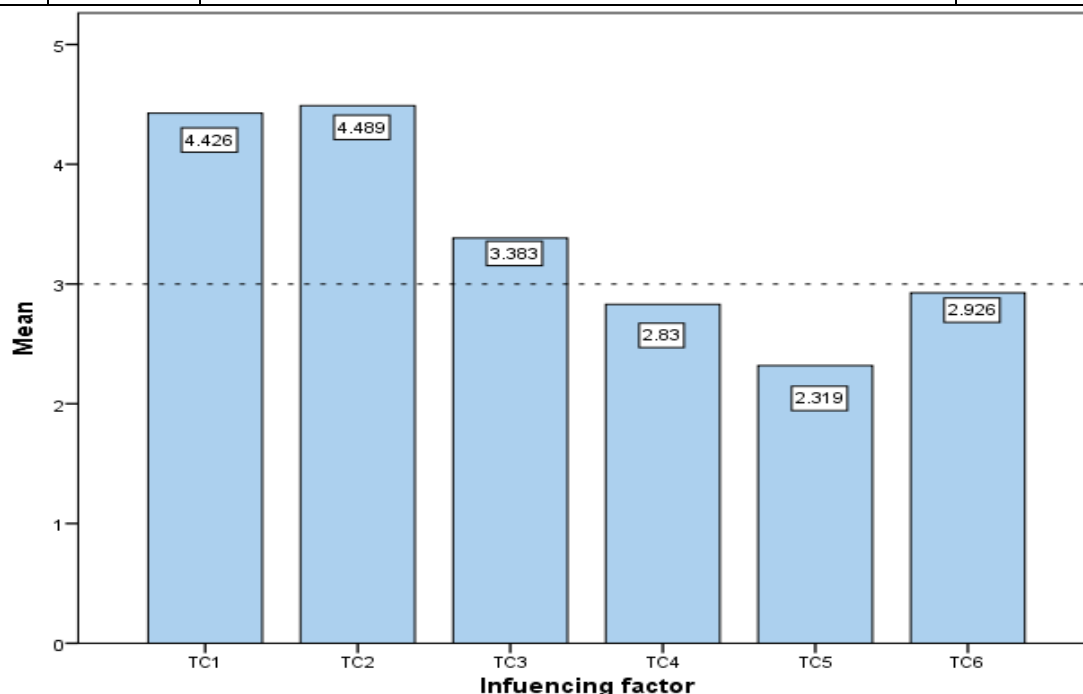
organizations such as; Mohamed [53] found that there is no effective leadership, wrong people in the wrong position, lack of top management support, and top management do not pay enough attention to quality programmes as well as they have poor understanding of quality systems and no clear vision. Al-Mijrab [114] found in LMCs there is a lack of top management support to quality programmes, wrong people in the wrong position. Alkisher [142] found that top management do not provide adequate resources to support introducing and implementing quality programmes. Elfaituri [143] found Top management do not allocate adequate resources and time for quality management efforts, Top management have no clear quality vision, and this also was found by Sherif [113].

#### 5.4.2 Training courses

The same analysis was carried out to find out the reasons behind training courses being a barrier to six sigma adoption to LMCs.

**Table 5.15: Factors influencing training courses**

Rank		Factor	Mean	Std.Dev.
1	TC2	There is a lack of six sigma trained professionals in our company	4.489	0.523
2	TC1	There are no six sigma training programmes in our company	4.426	0.538
3	TC3	There is a lack of six sigma training providers in Libya	3.383	0.745
4	TC6	The training managers are not effective and capable	2.926	1.108
5	TC4	In general, there is a lack of quality system training programmes in our company	2.83	1.009
6	TC5	There is no training department in your company.	2.319	1.087



**Figure 5.21: Factors influencing training courses**

The above table 5.15 and figure 5.21 show that only three factors out of six were identified as being impeding factors to training programmes. The first impeding factor with a Mean score of 4.489 was *“There is a lack of six sigma trained professionals in our company”*. Followed by *“There are no six sigma training programmes in our company”* with a Mean score of 4.426, then *“There is a lack of six sigma training providers in Libya”* with a Mean score of 3.383, while the other three factors were not considered as impeding factors to the training courses because their average mean scores were below 3. These factors were *“The training managers are not effective and capable”* Mean score 2.926, *“In general, there is a lack of quality system training programmes in our company”* Mean score 2.83, and then *“There is no training department in our company”* Mean score 2.319. These training impeding factors are similar to other studies on Libyan organizations by; Al-Mijrab [114] who found lack of expertise including absence of Libyan professionals and experts in quality management programmes, no accredited local quality agencies, and lack of trust in Libyan training programmes were impeding factors to training programmes. Sharif [55] found that there is a lack of experts and professionals in quality management. Mohamed [53] also found lack of expertise as one of the obstacles to training and quality systems, he also found that training managers are ineffective, which is slightly different from the findings of this study. The findings are also similar to other global studies on six sigma such as; Buch & Tolentino [86], Taner et al. [101], Hendry [91], Kwak & Anbari [96], Snee & Ronald [100], Gamal [89], who all found lack of dedicated six sigma professionals and inadequate specialized six sigma training are impeding factors to six sigma implementation.

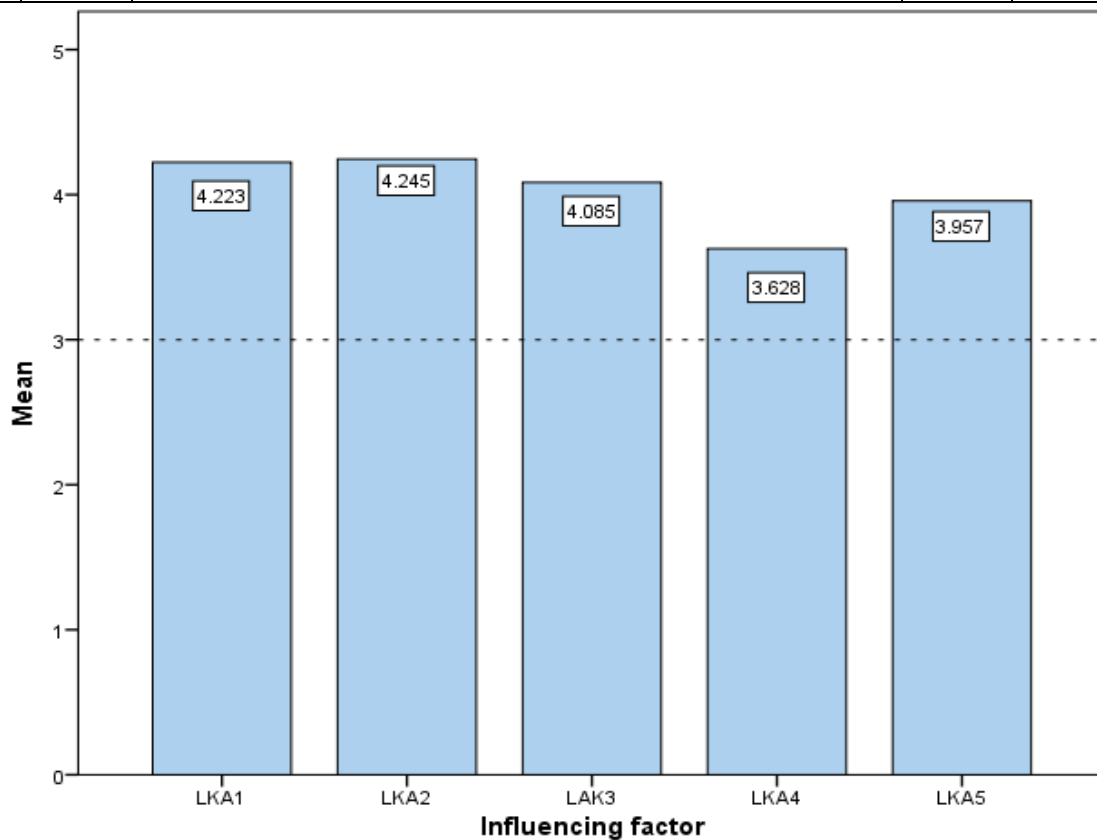
### 5.4.3 Lack of knowledge and awareness about six sigma

To identify the reasons behind the lack of knowledge about six sigma, respondents were requested to agree or disagree with the following five factors.

**Table 5.16: Factors influencing lack of knowledge and awareness about six sigma**

Rank		Factor	Mean	Std.Dev.
1	LKA2	There is a lack of information and awareness about six sigma in our company	4.245	0.497

2	LKA1	Most employees and managers in our company have a lack of knowledge about six sigma	4.223	0.628
3	LAK3	There is a lack of six sigma conferences, seminars, workshops and publications	4.085	0.600
4	LKA5	There is a lack of governmental bodies who support , make knowledge and awareness about six sigma	3.957	0.801
5	LKA4	There is a lack of local consultants and expertise in six sigma	3.628	0.762



**Figure 5.22: Factors influencing lack of knowledge and awareness about six sigma**

It can be seen from the above table 5.16 and figure 5.22 that respondents agreed with all the five factors (all Mean scores above 3) which means that the lack of knowledge about six sigma might be due to these factors. The first two reasons to the lack of knowledge about six sigma were “*There is a lack of information and awareness about six sigma in our company*”, and “*Most employees and managers in our company have a lack of knowledge about six sigma*”. Both Mean scores were 4.245 and 4.223 respectively. Followed by “*There is a lack of six sigma conferences, seminars, workshops and publications*” with a

Mean score of 4.085. The forth drawback was “*There is a lack of governmental bodies who support, make knowledge and awareness about six sigma*” with a Mean score of 3.957, then “*There is a lack of local consultants and expertise in six sigma*” came last with a Mean score of 3.628. These findings are similar to other studies on Libyan organizations such as; Elfaituri [143] in his study found that seminars and workshops involving quality systems issues were insufficient. Sharif [55] found that lack of information about quality system was one of the impeding factors, he also found that LMCs have a lack of employees awareness to quality programmes, and there is no government support. Sherif [113] found that employees have a lack of knowledge and understanding of quality systems due to the lack of awareness about these programmes, and no government support. This was triangulated by interview results with an LNCSM quality manager who stated there were no governmental bodies or local consultants supporting six sigma introduction. Other global studies on six sigma such as; Kokkranikal et al. [34], Kundi [35], Kumar and Antony [30, 31], Gamal [89], Antony and Desai [95] revealed that lack of knowledge about six sigma is one of the impeding factors to six sigma implementation due to the lack of awareness including information provision, communication, and six sigma expertise and professionals.

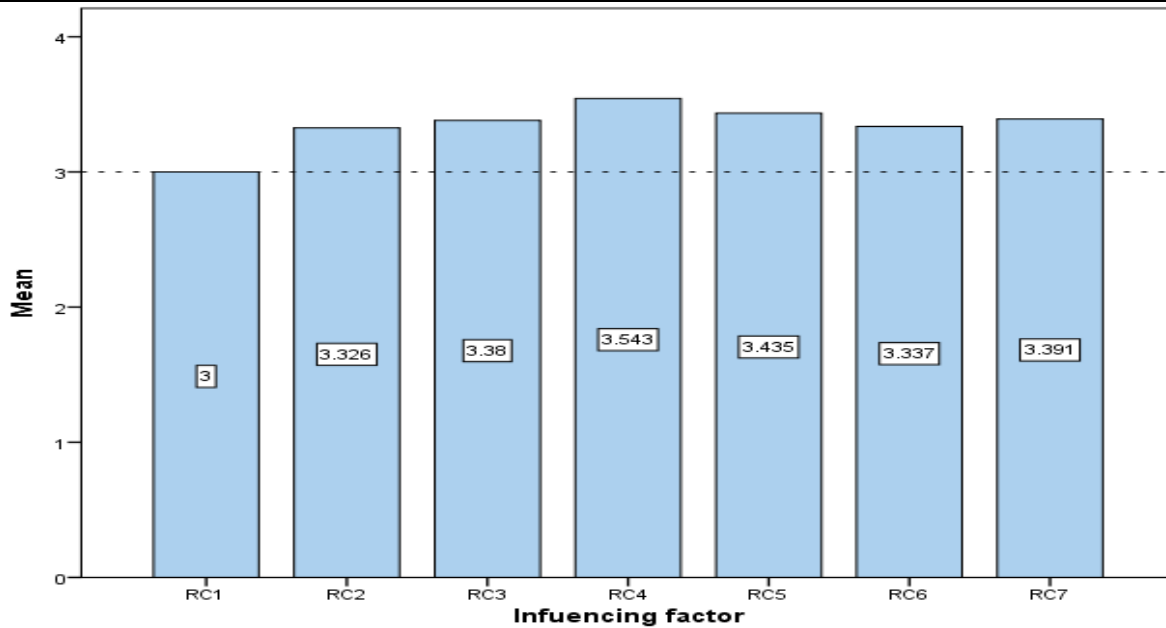
#### 5.4.4 Culture effect (resistance to change)

Average means score analysis was also applied to identify the reasons behind resistance to change as being one of the key barriers to six sigma adoption to LMCs. Seven factors were presented to respondents and they were requested to rate degree of concern on a five-point Likert scale.

**Table 5.17: Factors influencing resistance to change**

Rank		Factor	Mean	St.Dev.
1	RC4	There is a lack of knowledge about the advantages and benefits of the new techniques	3.543	0.906
2	RC5	People believe that a new technique will threaten their positions	3.435	0.975
3	RC7	There is an unwillingness to change from the existing system	3.391	0.916
4	RC3	There are difficulties in accepting new techniques & approaches in our company	3.38	0.940
5	RC6	People believe that a new technique will increase the workload and make it too complicated	3.337	0.965

6	RC2	The culture of resistance to change is spread throughout the company	3.326	0.979
7	RC1	In general, there is no desire to change	2.98	1.005



**Figure 5.23: Factors influencing resistance to change**

The above table 5.17 and figure 5.23 reveal that most respondents agreed that *“There is a lack of knowledge about the advantages and benefits of the new techniques”*. It was the first reason for resistance to change with a Mean score of 3.543. Then *“People believe that a new technique will threaten their positions”*, *“There is an unwillingness to change from the existing system”*, *“There are difficulties in accepting new techniques & approaches in our company”*, *“People believe that a new technique will increase the workload and make it too complicated”* came second, third, fourth, and fifth with Mean scores of 3.435, 3.391, 3.38, 3.337 respectively. The last reasons was *“The culture of resistance to change is spread throughout the company”* with a Mean score of 3.326. It is arguably that respondents disagreed with the statement *“In general; there is no desire to change”* as being one of the reasons behind resistance to change, Mean score was 2.98. These findings are similar to the findings of other studies on Libyan organizations such as; Sharif [55] found that resistance to change was due to employees and managers who were unwilling to change from the current system, employees want to escape from new responsibilities, a new system means extra work to them, and they have to learn more and develop their skills to meet the new system requirements, this leads to increasing workload and makes it too complicated. Mohamed [53] found that managers and employees did not have a full understanding and knowledge about

the new quality system adopted, so they tend to resist it, they also think a new quality system may affect them personally, and they might lose their job or position, because they are unqualified and inexperienced. Sherif [113] found that middle managers and employees did not want to follow the procedures required by the new system and they were happy with the current one, because they did not want to have new responsibilities and extra work, he attributed this to the lack of top management awareness about the requirements of the new quality system. Al-MIjrab [114] found, in many cases, employees were reluctant to have any changes made to their work processes as they envisaged the new system would be too complicated to understand, he also found that employees resist change because they fear things or events they do not know or understand.

#### 5.4.5 Correlation analysis

Correlation analysis was applied to check and measure the correlation between six sigma barriers. As mentioned earlier, a positive correlation between two variables means, if one increases, the other one will also increase. On the other hand a negative correlation indicates if one increases, the other one will decrease. Table 5.18 shows the correlation between the six sigma barriers.

**Table 5.18: Correlations between six sigma barriers**

			TMC	TC	LKA	RC
Spearman's rho	TMC	Correlation Coefficient	1.000	.577**	.345**	.602**
		Sig. (2-tailed)	.	.000	.001	.000
		N	96	96	96	96
	TC	Correlation Coefficient	.577**	1.000	.308**	.486**
		Sig. (2-tailed)	.000	.	.002	.000
		N	96	96	96	96
	LKA	Correlation Coefficient	.345**	.308**	1.000	.256*
		Sig. (2-tailed)	.001	.002	.	.012
		N	96	96	96	96
	RC	Correlation Coefficient	.602**	.486**	.256*	1.000
		Sig. (2-tailed)	.000	.000	.012	.
		N	96	96	96	96

\*\*. Correlation is significant at the 0.01 level (2-tailed).



\*. Correlation is significant at the 0.05 level (2-tailed).

TMC: Top Management Commitment

TC: Training Courses

LKA: Lack of Knowledge about six sigma

RC: Resistance to Change

It can be noticed from table 5.18, that all of the correlations are positive and statistically significant ( $p < 0.05$ ). It can also be seen from the table the correlation coefficient ( $r$ ) values were between 0.3-0.6 which indicates good relationships between all variables; the highest correlations were between top management commitment, resistance to change and training courses ( $r$ ), values were 0.602, 0.577 respectively. This was expected which reflects and supports what interviewees mentioned about top management when they said “lack of top management is usually followed by undesirable consequences”. This means when top management support the adoption and implementation of six sigma the other barriers (training courses, lack of knowledge about six sigma and resistance to change) will be tackled and improved as these barriers were evidently positively correlated and had a significant multi collinearity. Gamal [89] who established seven six sigma barriers found that that all of the correlations between six sigma barriers were positive and statistically significant, he also found that the correlation coefficient ( $r$ ) values ranged between 0.3-0.5.

## 5.5 Chapter summary

This Chapter presented the findings of the analysed data collected by questionnaire. The chapter was divided into four main subsections 5.1, 5.2, 5.3, 5.4. In the first subsection 5.1, general information about respondents and their companies was described utilizing a descriptive and demographic analysis to provide a summary using sum, frequencies, and percentages. Then the second part 5.2 dealt with the quality management and six sigma background to the responding companies to explore the current and previous quality management system and also to check if any of the LMCs have ever implemented six sigma. It has been determined that *none of the LMCs have ever implemented six sigma*. This supports the researcher’s earlier statement “*To date there is no evidence of the adoption of six sigma in the Libyan manufacturing industry*”. The third part 5.3 was important to achieve the research objective to identify the reasons and barriers impeding the adoption of six sigma in LMCs. Six key reasons were identified which are:-

- 1- “*Lack of six sigma training courses*”.
- 2- “*Lack of six sigma expertise and specialists in our company*”.
- 3- “*Lack of knowledge and awareness about six sigma in our company*”.

- 4- *“Lack of top management commitment”*.
- 5- *“Culture effect (resistance to change)”*.
- 6- *“We have not heard of six sigma, it is unknown to us”*.

Test of significance of differences (Kruskal-Wallis test) between the companies in terms of their organisational parameters such as (industry type, company size, ownership type, etc.) and six sigma barriers was also applied. Finally, in part 5.4 factors which have an influence on the identified barriers were highlighted and ranked according to their average Mean scores. Correlation matrix analysis was carried out to check the correlation between the identified barriers and their effect on each other.

In the next chapter, suggestions on how to overcome the barriers that face LMCs will be presented and discussed. Also the development of the implementation framework will be presented;

# Chapter Six

## 6 Development of the Implementation Framework

### 6.0 Introduction

The previous chapters 4 and 5 show that there was no evidence of six sigma implementation in LMCs. Hence, this chapter proposes the development of an implementation framework/roadmap that can be used by LMCs to guide them in successfully implementing six sigma in order to gain and sustain competitiveness in the local and global market. The researcher will develop the framework based on the data collected from LMCs from the survey findings in addition to the literature. Before proposing the framework, the researcher will suggest recommendations to LMCs to help them overcome the barriers they encounter for implementing six sigma, which were revealed by the survey, then a detailed implementation framework / roadmap that describes how six sigma can be implemented is presented.

### 6.1 Overcoming the barriers in LMCs

#### 6.1.1 Creating a culture of change in LMCs

The survey findings showed that one of the barriers that LMCs encounter is “culture effect” therefore this barrier has to be tackled before introducing the six sigma to the LMCs.

Authors believe that organizational transformation predominantly needs a cultural change, in order to achieve a dynamic, flexible, and adaptable atmosphere, where all organization staff should participate in problem solving, value adding results and corporate success [144]. This is where six sigma makes a good impact. However, for successful introduction of six sigma in LMCs, numerous attitudes have to be changed, thoughts developed and perceptions widened. Consequently, standards can be set and organization-wide commitment and continuous improvement appreciated. The essential changes will not be achieved without well-planned purposeful actions by the top management or leadership of LMCs.

Many quality initiatives may fail because; cultures do not readily accept change and do not effectively foresee the impact on human systems. Therefore, changing or adjusting the behaviour and attitude of people in the traditional bureaucratic organization within the Libyan environment is often not easy and encounters resistance. Thus, it is imperative for the Libyan

management to lead the organization through the quality transformation processes by establishing and demonstrating their own enthusiasm and willingness for change. They should continuously speak about the shared mission and vision of their organizations in terms of quality management; they should focus on the principles of customer services and the goals of the organization.

The main aim of changing the culture of LMCs is to implement the required values and morals. This can be reached by empowering the manpower to such an extent that they have clearly defined responsibilities, expectations, resources, skills and levels of authority.

Therefore, in order to create a culture of change; organisations must take into consideration a number of requisites, as stated by Schein [145]:

- ✓ The organization must be proactive, not just reactive.
- ✓ The organization must influence and manage the environment, not just adapt.
- ✓ The organization must be pragmatic, not idealistic.
- ✓ The organization must be future-oriented, not predominantly present/past oriented.
- ✓ The organization must embrace diversity, not uniformity.
- ✓ The organization must be relationship-oriented not just task-oriented.
- ✓ The organization must embrace external, as well as promote internal, connectivity.

Understanding the culture of an organization and utilising that knowledge to map the steps needed to achieve a successful change, is a significant part of the six sigma journey. Increasing the success of implementation strategies requires a good leadership in the management of resistance and it is essential to map the resistance factors, leadership have to build a new context that breaks the hold of the forces of resistance [146, 147]. Executive leadership management must assure that all stakeholder staff have a clear and strong vision about the nature of the change. They should recognise the whole impact of the change and the expected outcomes. Leaders should create guidelines for ethical behaviour and interactions, and develop a set of principles on how people are going to be treated, informed, and listened to. This could assure that all marginalised voices are heard and that a concern is demonstrated for the effects of radical change. Cultures with very tough traditions need clear signals about the commitment of leadership to avoid any issues of legitimacy in the change initiative [51].

### **6.1.2 Top management commitment**

Top management of LMCs must play a significant role in directing and organizing the company's efforts for change. There are substantial ways within the organisation where the top management can contribute to the introduction and implementation of six sigma. This contribution can be by supporting the programme, developing and establishing the vision, objectives, policies and strategies, assuring resources, attracting and bringing specialists and experts, eliminating the barriers, and monitoring implementation. Establishing the required policy, strategy, and to make a good communication at all levels in the company, is a part of the most essential factors impacting on the successful implementation of six sigma; thus increasing the impact of these essentials on the implementation is a very critical factor. The participation of everyone and top management commitment is considered as an enabling factor for implementing six sigma successfully [148-150].

The most dominant reason for failure of six sigma initiatives is that top management and their employees fail to address their roles, or a substantial part of them. Therefore, organisations should identify top management as a central factor in successful implementation. This can be demonstrated by establishing role models, developing a clear mission and vision, developing a comprehensive strategy and goal setting and planning and creating the elements of a new quality programme structure and thus, top management should first show their intent and commitment to implement six sigma in order to achieve all the previous actions [151, 152].

### **6.1.3 Awareness of six sigma**

Awareness of six sigma was also one of the barriers to six sigma adoption in LMCs and needs to be overcome. Crosby [153] said that the purpose of awareness is to make everybody feel that he/she belongs to a quality organisation. Also, awareness means that everyone in the organisation understands the quality policy. LMCs' top management must present the awareness of six sigma in a clearly understandable way. If the levels of awareness in an organisation are very low, this can lead to a poor understanding about the importance of six sigma. It is a result of lack of information, education and training programmes available about six sigma [118]. Thus, awareness programmes about six sigma must be highly considered before the implementation journey starts.

### **6.1.4 Training programmes**

The survey findings revealed that LMCs have a lack of six sigma training programmes. Hence, to successfully adopt and implement six sigma or any quality programme, training for

all LMCs must be delivered and carried out relentlessly. All employees in the LMCs should be given the opportunity to know what six sigma is all about and what their part is in this process. Appropriate training programmes should be provided to give all organization work force the required levels of awareness to enable them perform actively with the newly implemented system.

At the beginning of the six sigma journey, training programmes should be delivered to all staff including top management; this can provide general knowledge and awareness about six sigma. Management in a leadership positions must receive proper education and training in six sigma principles and fundamentals. Without this, it is hard and challenging for managers to make and lead the necessary changes of organization culture. Training should also be provided to the shop floor workforce to address their needs and skills. Support should be developed to help employees during the period of change [154-156].

#### **6.1.5 Government support**

The Libyan government should play its role in terms of encouraging organizations to adopt quality programmes by creating quality regulations and adopting foreign investment policies. Gosen et al.[157] said “in developing countries, political and legal factors are crucial to the improvement of quality systems”. He also said “ in developing countries governments can be more supportive of adopting and implementing quality programmes by providing financial and technological support, giving the priority to industrial development and allocating different funds to support organisations in implementing these programmes”. Government should also ask organisations to be certified in order to make it simple to deal with other organizations, which are already certified. In this regard, LNCSM should play its role by providing six sigma awareness programmes, training courses as well as holding conferences and workshops about six sigma alongside the other programmes they already run

#### **6.2 Six sigma implementation framework**

The purpose of this framework is to bring an attitudinal change and transformation to LMCs and to set the direction for the implementation of six sigma initiative. However, before presenting the framework the terms *implementation and framework* need to be defined and clarified.

## **6.2.1 Definitions**

### **6.2.1.1 Implementation**

The definition of the term implementation according to the common standard dictionary is “to *put into effect according to some definite plan or procedure*”. Pressman and Wildavsky [158] said that implementation is “to carry out, achieve, fulfil, produce and complete”. Wheelen and Hunger [159] defined implementation as “processes by which policies and strategies are placed into action, the implementation processes must begin with a starting point, If no action is started, then implementation cannot happen, and they must also finish with an endpoint” .

The above definitions and descriptions indicate that implementation is a set of activities or processes. When considering six sigma implementation, a definition that denotes implementation as a process seems more suitable. Hence, because of the fact that the topic of six sigma is carried out at project level, which includes a well-established methodology (DMAIC), a process of activities is needed.

### **6.2.1.2 Framework**

Popper [160] defined a framework as “a set of basic assumptions or fundamental principles of intellectual origin in which discussions and actions can proceed”. While Aalbregtse et al. [161] defined a framework as “a clear picture of the leadership goals for the organization and should present key characteristics to be style of business operations”. Consequently, when six sigma is to be ideally designed and constructed, we need to have the full picture and structure for its implementation, which is considered as a framework for carrying out those relevant and essential activities.

Aalbregtse et al.[161] stated some reasons why a framework is needed:-

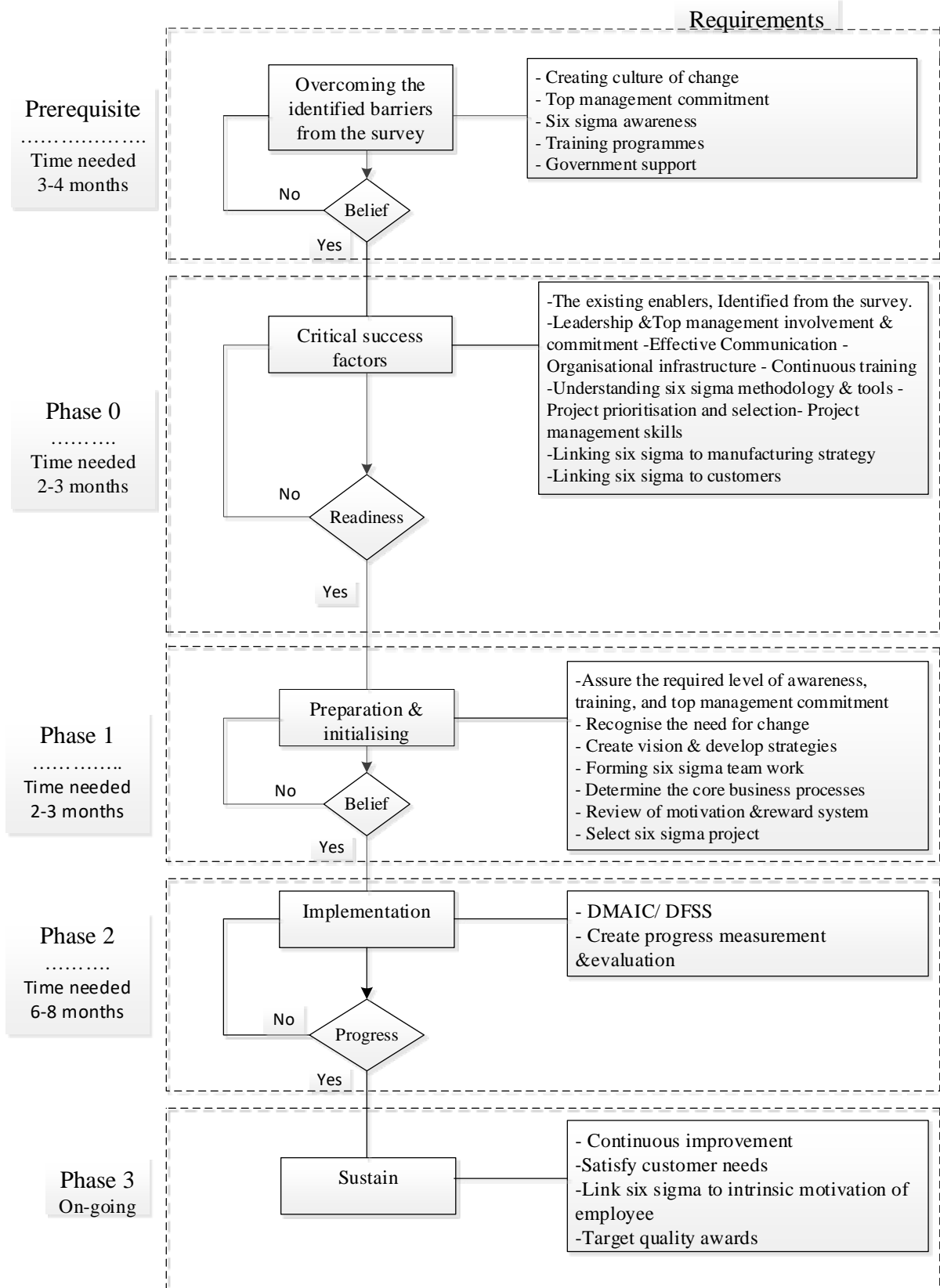
- ✓ To illustrate and clarify an overview of quality practice so as to communicate a new vision of the organization
- ✓ It forces management to address an important list of key issues which otherwise might not be addressed
- ✓ It gives an insight into the organization’s strengths and weaknesses
- ✓ Most importantly to support implementation and to improve the chances that a quality practice will be successful

Developing an ideal implementation framework is crucial, therefore should be one of the first steps to be achieved before embarking on six sigma projects. The framework will make LMCs more aware of six sigma, and enable them to introduce and adopt its components and features in a comprehensive and controlled manner.

### **6.2.2 The proposed framework**

The proposed framework was built upon previous quality and six sigma initiative frameworks, incorporates unique phases, and stages for LMCs taking into consideration the collected data from the survey findings about these companies. This implementation framework will act as a roadmap or a guideline for LMCs to lead them towards successful embracing of six sigma, as well as to improve continuously and maintain high standards of quality. The proposed framework consists of four phases in addition to the prerequisite stage. Figure 6.1 shows the proposed implementation framework for LMCs with the estimated required time for each phase.





**Figure 6.1: The proposed implementation framework for LMCs**

### **6.2.2.1 Prerequisite**

This unique phase was specifically designed for LMCs based upon the barriers that they encounter which were extracted from the survey findings. The researcher has suggested how to overcome these barriers and they were fully presented and explained in section 6.1. Once a LMC believes that those barriers have been completely eliminated and they are no longer facing them, they can proceed to the next phase. This stage is considered as prerequisite, so they cannot proceed without accomplishing it.

### **6.2.2.2 Phase 0:**

#### **1-Critical success factors (CSFs)**

The first step of this phase is to make sure that all CSFs are available in the LMCs, because the success of six sigma implementation depends on the availability of these factors. The CSFs are those factors that are critical to the success of a company. In the sense that if objectives linked with the factors are not achieved the company will fail [27]. The survey findings found that LMCs have already got some existing CSFs or enablers which help them to successfully implement six sigma. These enablers were mentioned in detail in sections 4.3.6.2 and 5.3 and include “sufficiency of time and financial resources”; “customers unsatisfied”; “good communication between all departments in the company”; “certainty about the results and benefits of six sigma, and unhappy with the current quality system”.

In addition to the existing enablers, LMCs should also consider the following CSFs, which were identified from the literature review.

- **Leadership and top management involvement and commitment:**

The survey findings revealed that LMCs have a lack of top management commitment therefore this factor should be highly considered. Many researchers reported this factor as one of the most important factors to the success of six sigma implementation such as, Henderson and Evans [28] , Anotny and Banuels [162] because it improves performance by influencing other factors, therefore six sigma should be everyone’s job including leaders and top management. Hence, LMC managers must be involved in the creation and management of the process management system, and also participate in projects themselves, without the leadership and top management commitment and support the introduction and implementation of the initiative will be in doubt.

- **Effective communication:**

An effective communication plan is essential to involve the staff with the six sigma initiative by showing them how it works, how it is relative to their job, and the benefits from it. By doing so, resistance to change can be reduced [28]. It is really important to create a plan that describes what should be communicated by whom and how often, also after implementing the six sigma projects, it is recommended to internally publish results of the benefits that an organization gained, and this not restricted to success but also to admit and communicate setbacks, in order to avoid them in the future projects [29]. It is worth mentioning that the survey findings showed that LMCs have good communications, so this will play a big role in facilitating the implementation of six sigma in these companies.

- **Suitable organizational infrastructure:**

In order to successfully implement six sigma, some organizational characteristics must be in place. For example, it is desirable to have communication skills, long-term focus/ strategy and teamwork. It is also necessary to have sufficient resources and investment to embark on six sigma [29].

- **Continuous training:**

Training is a crucial factor in successful implementation of six sigma projects, because it provides a clear sense for employees to better understand the basics, tools, and methodology. Training is considered as a part of the communication systems to ensure that managers and employees apply and implement six sigma efficiently and effectively. Every six sigma project should have the different belt levels (Master, Black, Green, and Yellow) to ensure that the establishment and implementation of the project is done seamlessly [96]. The survey findings showed that LMCs suffer from a lack of six sigma training. Hence, all LMCs should continuously learn, train, and adapt the latest trends and techniques that are outside the six sigma domain which may be useful to complement the six sigma approach.

- **Understanding six sigma methodology and tools:**

The survey findings showed that none of the LMCs have ever implemented six sigma. Consequently, the six sigma approach will be a new system for LMCs, therefore, it is important to fully understand the use of six sigma methodology and tools. To affect this, the six sigma teams need to be fully familiar and trained on the application of particular tools and

techniques, the most critical of which include statistical analysis, project management skills, and process management. A balanced integration and combination of these tools is a recipe for successful six sigma outcomes [35].

- **Project prioritisation and selection:**

A six sigma project needs to be carefully selected and planned to maximise the benefits of its implementation, as a poorly defined and selected project could lead to delayed and unacceptable results and also great frustration. The project selection process should involve listening to four important voices: voice of the customer, voice of the business, voice of the process, and voice of the stakeholders [102].

The following are guidelines for good selection of a six sigma project [104]:

- The project must be clearly linked to the strategic goals of the business.
- The problem should be of major importance to the business, in regard to cost, quality and customer satisfaction.
- The project should be doable in six months. If the project scope is too long, the completion time increases and as a result the costs of the project will go up, leading to frustration due to lack of progress, delays in gaining financial impact on the bottom-line, etc.
- Project goals must be concise, measurable, achievable, and be accomplished within the pre-defined time limit.
- The project should have the approval and support of senior management
- Establish project selection criteria – the following criteria should be considered during the project selection process:
  - Impact on customer requirements and expectations.
  - Financial impacted on the bottom-line.
  - Project duration needs to be considered.
  - The required resources for the project.
  - Professionals and skills needed to achieve the project.
  - Probability of success and failure of the project undertaken.
  - Risks involved in the project.

- **Project management skills:**

Another key factor, which needs to be considered by LMCs in implementing six sigma, is that project managers need to have the required project management skills. Most of the projects do not succeed due to poor management skills, setting plans, setting and keeping ground rules. [163]. LMCs' project managers need to think about the key fundamentals of project management, time, cost and quality. Considering them will give the team the goal, scope, and resources required to deliver an improvement in a short time, with low cost and meeting the requirements needed [29].

- **Linking six sigma to manufacturing strategy:**

Six sigma cannot be dealt as another- stand-alone activity. It needs adherence to the whole philosophy instead of just the practice of a few tools and techniques of quality improvement [164]. Top management have to think about how to link six sigma strategy with other manufacturing strategy to each other in order to enhance the whole competitiveness of the company [165]. Since the competitiveness of most companies is to increase profits, six sigma strategy might be considered to make the business process profitable while attacking variability which leads to high rework rate, high scrap rate, and low productivity [162].

- **Linking six sigma to customers:**

Customers are the key concern of six sigma philosophy. Six sigma should start and end with the customers. Projects should listen to the voice of customers and should also satisfy all of the customers' requirements [165]. Therefore, the six sigma process should be linked to the customers and this could be in two steps [166, 167]:

- Identifying the core process, defining the key outputs, and defining key customers that they serve.
- Defining the customer needs and expectations.

A significant issue here is the identification of the critical-to-quality characteristics (CTQ). Six sigma is a performance target that applies to a single CTQ, not to the whole product contrasting to other total quality management initiatives. CTQs or customer's "wants" are identified [29].

## **2- Readiness**

This step will test the readiness of a LMC before embarking on the six sigma programme. The readiness index will evaluate the company's readiness for six sigma adoption and implementation. The criteria on how to measure the readiness of the company is based on achieving and meeting all the requirements which were mentioned above (prerequisite and CSFs). The test of readiness can be done as recommended by Kumar et al. [39] who stated that all criteria should assign equal weight in evaluating the readiness index score. A score is calculated for each variable within each factor on the 1-5 Likert scale. A score of above 3 for each criterion means that the company is ready to embark on six sigma.

### **6.2.2.3 Phase 1- Preparation and initialising**

As six sigma is a new technique for LMCs, this phase helps to thoroughly understand the reasons behind the change, also assure and measure the awareness, training and commitment from top management to allocate time and resources for the change as well as selecting the proper project. This phase requires the following steps:

- **Assure the required level of awareness, training, and top management commitment:**  
Appropriate and suitable awareness and training is a critical first step. As the survey findings showed that lack of top management commitment awareness, and training about six sigma is a barrier to the implementation of this technique, therefore, further emphasis is needed in LMCs to ensure the employees, at each relevant level and function, are aware and awake of culture, quality policies, and procedures of the six sigma technique. Extensive training is required, particularly in the areas of problem identification and solving. Top management must recognise the importance of the fundamentals that they are considering and be prepared to communicate this effectively, before they commit themselves. Top managers need not only to educate and train themselves but also their employees. Quality managers are required to deliver training sessions for their employees, describing what six sigma is, what its benefits are, and explaining the necessary preparative steps for its implementation before embarking on the implementation processes. Failure to consider such values may lead to serious consequences.
- **Recognise the need for change:**

At this step, LMCs must identify and justify the need for six sigma implementation. This need for its launch could be externally demanded by customers and market requirements, for example when a customer complains to reduce the defects in the products. Outsourcing to low cost manufacturing countries, decline in market share, or change in the Libyan government policies and regulations could force the company's leadership to consider the need for six sigma adoption.

The need for change could also be internally, for instance driven by employees (internal customers) for their satisfaction, or it could be for changing the business focus or management change. The external factors could be intertwined with the internal ones driving the change. For instance, customer complaints could force internal factors such as process or quality of products to improve. Applying the business review and gap analysis will facilitate identification of the strengths and weaknesses of the company and also prioritisation of the potential change required [39].

- **Create vision, and develop strategies:**

At this level, a vision is needed to direct and support the change, and develop strategies for carrying out that vision, where top management need to create a vision and develop strategic plans to help company's members to accomplish the organisational goals. This vision must be a guide to the six sigma team to find the way in which the company is moving through change [168].

- **Forming six sigma team work:**

Forming an influential guiding team of black, green and yellow belt members. Assembling a group with sufficient power and authority to lead the change. Encouraging and motivating the group to work together as a team. This step is the commitment of the top management to form the team. This team will spread news of the philosophy changes, gains, and success through the company's members. These teams may have a small number of members but they must be committed to the six sigma programme. If there is no support from the top management or the leadership toward the change process, it will be hard to achieve.

- **Determine the core business processes:**

It is an area for a potential bottleneck to identify the core processes for many companies. Because the framework will be difficult to implement if the core processes are unknown [169]. It becomes simpler to understand the processes and find the opportunities for improvement, if the process mapping and values stream mapping for the core processes have been performed to identify value-added and non-value-added activities [39]. It is preferable to launch six sigma by focusing on a few strategic areas, rather than too many [170].

- **Review of motivation and reward system**

As this technique will be new for all the staff within LMCs, the motivation and reward system should be reviewed. The purpose of a motivation and reward system is to influence employees' performance by emphasising desirable values and behaviour. Companies that successfully implement six sigma or any quality initiative endeavour to set up a system, which catches employees in the act of doing the proper thing from a value or behavioural perspective [171]. The most important reason for a company to set up a rewards system is to encourage and motivate its employees to work harder and act more effectively. Sallis [172] believes that to perform a good job, employees need motivation and recognition of their achievements and successes. They want managers who appreciate their work and lead them to even bigger success. Indeed, motivational practices become an important tool for many companies to achieve their goals. This system could be a mix of two kinds of rewards: tangible ones and intangible ones, such as employees receiving recognition for work well done

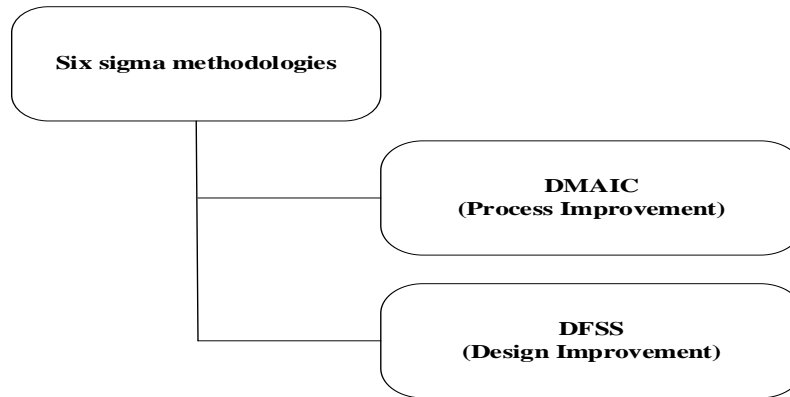
- **Select the six sigma project:**

As mentioned early, the selection of the six sigma project is a critical and crucial component of success. As poorly selected project could lead to losing the battle before it even starts. The decision of selecting the project should be focused on key problem areas along with customer satisfaction, faster and larger financial return [173]. The time of project completion should be also considered, the shorter the better, with less effort and large impact regarding the productivity and profitability [174, 175]. Therefore, the six sigma project needs to be carefully selected and planned to maximise the benefits of its implementation to make every one motivated and interested in the next project.



#### 6.2.2.4 Phase 2- Implementation

There are basically two methodologies for six sigma implementation that LMCs can apply as shown in figure 6.2

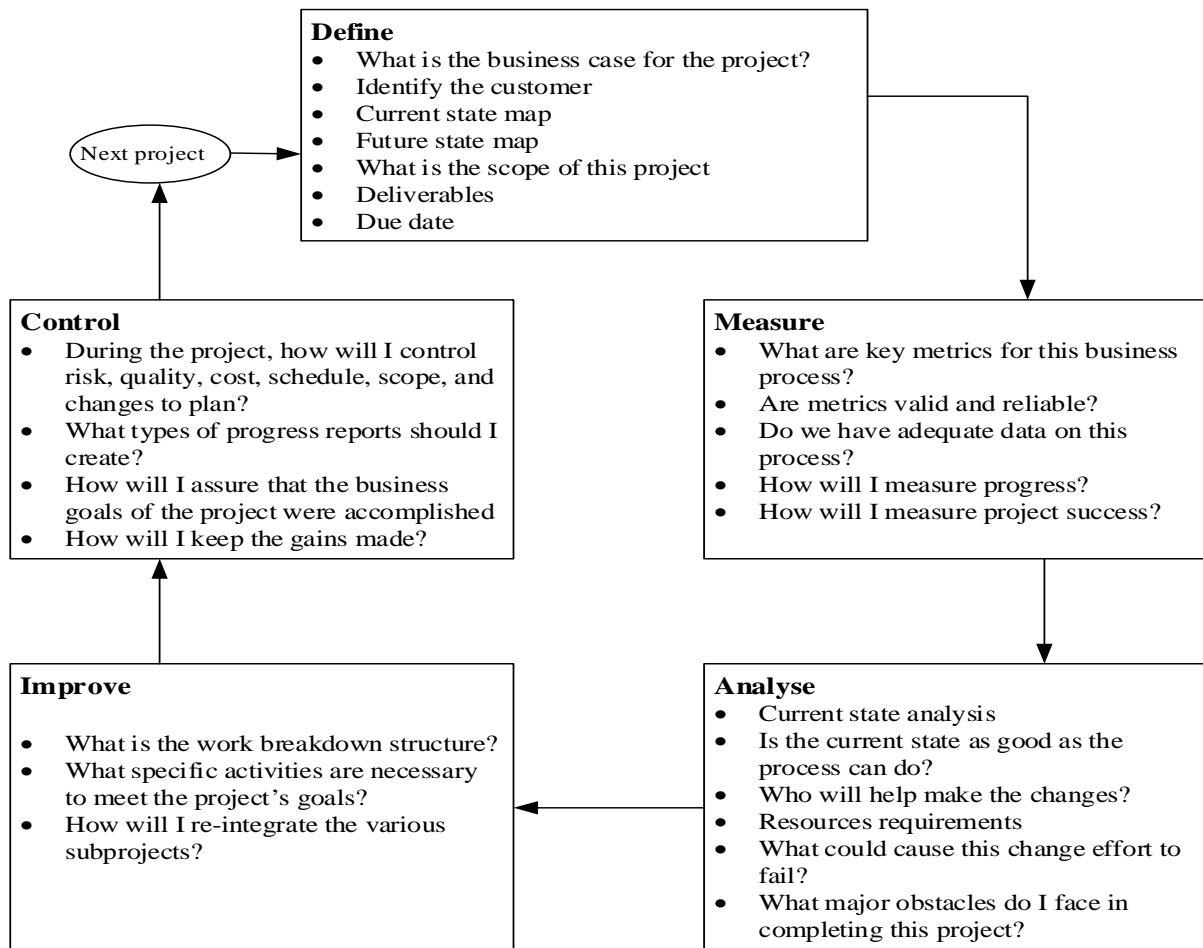


**Figure 6.2: Six sigma methodologies**

DMAIC methodology (Define- Measure- Analyse- Improve-Control) is a methodology used for process improvement in other words it is applied for existing products and processes when their performance is inadequate. The other methodology is DFSS, Design for Six Sigma, which is used for design improvement, the most popular approach for this methodology is DMADV (Define- Measure-Analyse-Design-Verify) which is applied for new products and processes [37, 38]. The selection of which methodology to use depends on whether the project is for process improvement or design improvement.

DMAIC is the most used and popular methodology for six sigma implementation, it offers a structured and disciplined process for solving business problems. Six sigma uses tools designed to identify root causes for the defects in processes that keep an organisation from providing its customers with the consistent quality of products they require on time and at the most reasonable cost [38].

The elements of the DMAIC phases are explained below in figure 6.3 and table 6.1 including the most appropriate managerial and statistical techniques and tools in support for each phase [173].



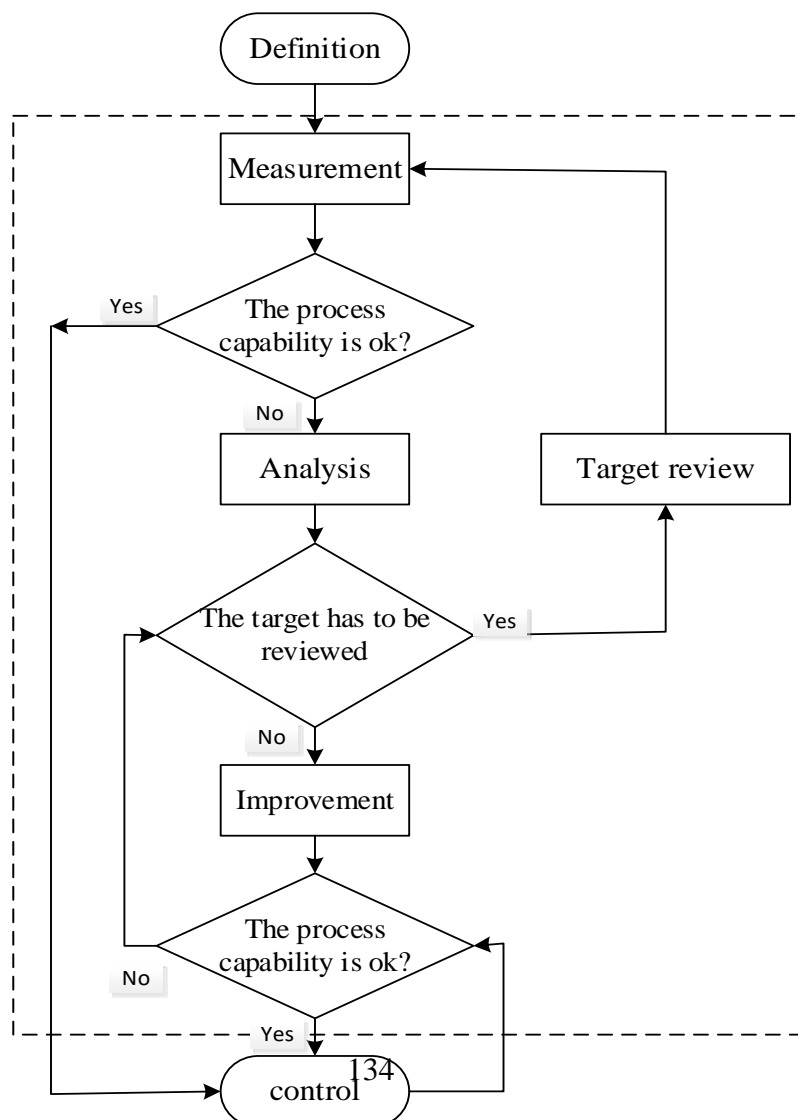
**Figure 6.3: DMAIC cycle**

**Table 6.1: DAMIC phases and activities [173]**

<b>Phase</b>	<b>Action / activity</b>	<b>Six sigma tools</b>
<b>Define</b>	<ul style="list-style-type: none"> <li>- Define Customers and Requirements (CTQs)</li> <li>- Develop Problem Statement, Goals and Benefits</li> <li>- Identify Champion, Process Owner and Team</li> <li>- Define Resources</li> <li>- Evaluate Key Organizational Support</li> <li>- Develop Project Plan and Milestones</li> <li>- Develop High Level Process Map</li> </ul>	<ul style="list-style-type: none"> <li>- Project charter</li> <li>-Voice of the customer</li> <li>-Process mapping</li> <li>-Kano analysis.</li> <li>-Value stream mapping</li> <li>- SIPOC</li> <li>- Process flowchart</li> <li>- CTQs definitions</li> </ul>
<b>Measure</b>	<ul style="list-style-type: none"> <li>-Define Defect, Opportunity, Unit and Metrics</li> <li>- Detailed Process Map of Appropriate Areas</li> <li>- Develop Data Collection Plan</li> <li>- Validate the Measurement System</li> <li>- Collect the Data</li> <li>- Determine Process Capability and Sigma Baseline</li> </ul>	<ul style="list-style-type: none"> <li>-Data Collection &amp; Sampling</li> <li>- Data Reliability &amp; Validity</li> <li>- Gauge R&amp;R and Process Capability</li> <li>- Sigma Rating, DPMO</li> <li>- Cost of poor quality</li> <li>-Measurement system analysis</li> <li>- Run charts</li> </ul>
<b>Analyse</b>	<ul style="list-style-type: none"> <li>- Define Performance Objectives</li> <li>-Identify Value/Non-Value Added Process Steps</li> <li>- Identify Sources of Variation</li> <li>-Determine Root Cause(s)</li> </ul>	<ul style="list-style-type: none"> <li>-Cause and effect analysis</li> <li>- Histograms - Pareto analysis</li> <li>-FMEA – statistical analysis</li> <li>-Comparing Means Medians</li> <li>- Control charts- analysis of variance</li> <li>-Hypothesis testing</li> <li>- Correlation &amp; regression</li> </ul>
<b>Improve</b>	<ul style="list-style-type: none"> <li>-Perform Design of Experiments</li> <li>- Develop Potential Solutions</li> <li>- Define Operating Tolerances of Potential System</li> <li>- Assess Failure Modes of Potential Solutions</li> <li>-Validate Potential Improvement by Pilot Studies</li> <li>-Correct/Re-Evaluate Potential Solution</li> </ul>	<ul style="list-style-type: none"> <li>- Mistake proofing</li> <li>- Design of experiments</li> <li>- Prototype &amp; pilot studies</li> <li>- Project planning &amp; management tools</li> <li>-Total process maintenance</li> <li>- Simulation software</li> </ul>
<b>Control</b>	<ul style="list-style-type: none"> <li>-Define and Validate Monitoring and Control System</li> <li>-Develop Standards and Procedures</li> <li>-Implement Statistical Process Control</li> <li>-Determine Process Capability</li> <li>-Develop Transfer Plan, Handoff to Process Owner</li> <li>-Verify Benefits, Cost Savings, Profit Growth</li> <li>-Close Project, Finalize Documentation</li> <li>-Communicate to Business, Celebrate</li> </ul>	<ul style="list-style-type: none"> <li>-Control plans</li> <li>- Control charts</li> <li>-Cost savings calculations</li> <li>-Reporting system</li> <li>-Financial project appraisal</li> <li>- SPC</li> </ul>

- **Phase D -Define:** The first phase of the DMAIC process aims to identify the product or process that needs improvement and intervention through six sigma. This is a very significant phase because all of the proceeding phases depend on it. It measures customer complaints, reports on non-compliance, and suggestion from employees. For this phase, some useful tools can be utilised such as Project charter, Voice of the customer, Process mapping and so on, see table 6.1. The identification of the product/process on which to act, mainly includes some activities such as: define the requirements and expectations of the customers; develop the problem statement, goals and benefits; identify the champion, process owner and team; define resources; and so on. See table 6.1 [176].
- **Phase M -Measure:** Measure the existing system. Establish valid and reliable metrics to help monitor progress towards the goals defined at the previous phase [173]. This phase includes some activities such as, develop a data collection plan, validate the measurement system, and collect data, see table 6.1. The tools used for this are also shown in table 6.1 such as gauge R&R and process capability, sigma rating, DPMO, and cost of poor quality.
- **Phase A -Analyse:** This phase aims to assess the data collected in the previous phase, evaluating this through statistical methods, assessing the process centring and variation, the process stability, identify value/non-value added process steps, the trend of product/process performance, and also making assessments in terms of DPMO [176]. Several basic activities and statistical tools can be utilized to support this phase as shown in table 6.1.
- **Phase I -Improve:** In this phase, solutions and improvements are identified and implemented to address the root cause of the problem. Creativity may be needed to identify new methods or best tactics with a validated record of success. Some team members might wish to continue using current practices; however, the team's analysis has proved that those methods are invalid or inadequate, so the team must identify new methods. Once new approaches are identified, an implementation plan is required. Other related processes may be impacted by this change, so these processes may also require assessment [5]. A number of basic activities and statistical tools can be utilized to support this phase as shown in table 6.1.

- Phase C -Control:** After the implementation of improvement activities, monitoring becomes important to control the process [21]. Controls are developed to prevent the problem from happening again and to ensure that fixes are maintained over time [5]. For this, statistical process control tools are used, in particular the control charts, see table 6.1, to monitor and provide evidence of the results emerging from the new process conditions. After a period of adjustment, process capability is assessed again, and, depending on the evidence arising from this analysis, it could be required to review all or part of the DMAIC path. Another activity at this stage is to ‘institutionalise’ the accomplished finding and results [39]. It could be, for example a need to update the flow-chart, the procedure or the process/product that has been affected by the Six Sigma project. Institutionalisation can also be made through an estimate of annual savings, for example in terms of costs due to the implemented improvement. Finally, it is important to announce and disseminate the results of six sigma within the organisation, through the production of short reports. The below figure 6.4 shows a flow chart of the DMAIC path [176].



#### Figure 6.4: DMAIC path

The other six sigma methodology is DFSS- Design for Six Sigma. This methodology is used when the goal is the development of a new or radically redesigned product, process or service [173]. The DFSS is characterised by the integration of statistical and managerial techniques, and enables organisations to more effectively manage their development process of new products through the optimisation of several key factors such as costs, time to market, and so on [177]. For DFSS methodology, there are different approaches in use such as DMADV (define-measure-analyse-design-verify), IDOV (identify-design-optimize-validate) and DIDES (define-initiate-design-execute-sustain) [178].

DMADV is considered the most common approach for DFSS and includes the following phases [173]:

**Phase D-Define:** Define the goals of the design activity. What is being designed? Why? Use Quality Function Deployment QFD, or the Analytic Hierarchical Process to assure that the goals are consistent with customer demands and enterprise

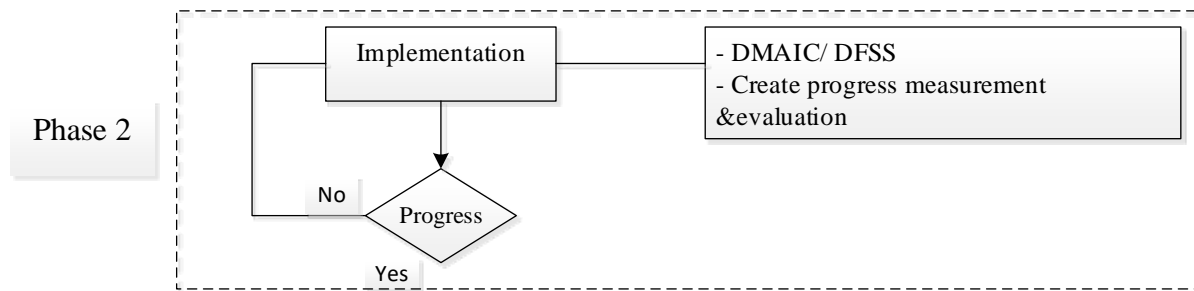
**Phase M-Measure:** Determine Critical to Stakeholder metrics. Translate customer requirements into project goals.

**Phase A-Analyse:** Analyse the options available for meeting the goals. Determine the performance of similar best-in-class designs.

**Phase D-Design:** Design the new product, service or process. Use predictive models, simulation, prototypes, pilot runs, etc. to validate the design concept's effectiveness in meeting goals.

**Phase V-Verify:** Verify the design's effectiveness in the real world.

The next step in the implementation phase is to create progress measurement and evaluation see figure 6.5.



**Figure 6.5: Phase 2**

The aim of any measurement system is to provide feedback, relative to the company's goals, that increases its chances of achieving these goals efficiently and effectively.

In the first-phase (recognise the need for change) where the gap analysis was applied will help to identify the critical business processes and create the metrics to measure the performance of those processes. Good performance measurement leads to identifying target areas for improvement and has a key role in communication [179]. These metrics need to be regularly monitored and reviewed. It is equally significant to measure the non-financial metrics such as customer satisfaction, employee satisfaction, job involvement and commitment, to name a few, which are the key indicators of any change initiative. The key points to be accentuated upon in this step are [39]:

- Develop standard procedures and systems for results recording and reporting.
- Highlight the successful as well as poor results and feedback to employees.
- Members of supervisory team accountable for reporting results for their individual processes.
- Establish a monthly review of on-going projects, identify performance trends, evaluate progress and revise strategies.

#### **6.2.2.5 Phase 3- Sustain**

Once the implementation phase is achieved, LMCs should sustain the success. The Sustain phase aims to put emphasis on how learning from the previous phases could be transferred, shared and applied across the company to continue gaining benefits on a long-term basis from the implementation of six sigma. The rationale behind including this phase is to make sure that the knowledge and benefits generated from six sigma projects are sustained on a long-term basis [39].

- **Continuous improvement:**

Continuous improvement (CI), means making things better. It refers to all efforts that are directed at increased efficiency and effectiveness in meeting customers' expectations. Continuous improvement is not only linked with solving problems, it is a continuous processes to achieve a better understanding of the market, to innovate products and processes, to manage and distribute material and products, and to achieve products of high quality, greater than customer requirements [180, 181].

Continuous improvement of the company's overall performance should be a permanent goal. It is a permanent goal for any company that wishes to stay in business. In order to keep the momentum, it is important to develop generations of managers, who not only understand but are dedicated to the pursuit of continuous improvement in meeting external and internal customer needs [169]. This is the first step towards long-term sustainability of the six sigma initiative.

- **Satisfy customer needs**

Successful companies continually change and innovate, based upon customer requirements and feedback. Understanding customer satisfaction and dealing with their needs and the ability to meet their expectations has a direct impact on the company's revenue performance. Therefore, it is recommended to conduct regular customer surveys to measure a change in the level of customer satisfaction. There are many ways of measuring customer satisfaction from various channels, such as surveys, customer complaints, focus groups, and combine this data in an attempt to get an accurate measure of customer satisfaction. Customer feedback is also very important for the success of the company [43] .

Once the customer feedback is collected and the input provided by the customers is ready, it should then be carefully evaluated and used to improve the overall satisfaction level of all customers.

- **Linking six sigma to intrinsic motivation of employees:**

Employees are the main source of thoughts and innovation, and their knowledge and experience should be utilised to get these ideas implemented [169]. Management should believe and trust in the power of 'intrinsic motivation' (self-motivation) rather than solely relying on 'extrinsic motivation' (coerced or bribed to do it) [170]. The intrinsic motivation can be generated from [39]:



- ✓ Employees involvement in project improvement teams or review meetings
- ✓ Employees empowerment for their processes
- ✓ Training and development for their career progression
- ✓ Reward and recognition schemes

- **Target quality awards:**

Countries around the world have already started to establish quality awards, with a view to promoting quality awareness within the productive processes with the purpose of fostering the data exchange. This encourages and motivates organisations and firms to adopt new plans and strategies for quality improvement. These awards recognise those organisations that have implemented successful programmes [182]. Ghobadian and Woo [183] summarised the main aim of quality awards as, “to increase the awareness and success of the implementation and deployment of quality programmes, creating the ability to enhance the competitiveness of organisations, encourage organisations in continuous improvement of products and process, encourage the use of self-assessment methods, and to promote understanding of the requirements for achieving quality and customer satisfaction”. Hence, LMCs should seek and target these awards to stay in business and survive.

There are three commonly used self-assessment models of quality awards, which are Japan's Deming Application Prize, the Malcolm Baldrige National Quality Award (MBNQA), and the European Quality Award (EQA).

### **6.3 Validity assessment of the framework**

Validity assessment of the framework is necessary in order to check how well the framework conforms to the aim and the purpose that it was created for. Validity assessment is different from testing, an assessment of the assumptions, concepts, and data is utilized to build a model / framework, for logical consistency, and the review is assisted by input from professionals knowledgeable in real world situations [184]. However, testing is a real-life implementation method of the framework; it is used in order to check whether or not the obtained outcomes and the anticipated outcomes are the same. Kumar [185] stated “validity is determined without directly confirming knowledge. Confirming the knowledge is achieved by testing in a case study implementation”. In this research, testing the framework in a case study is beyond the scope due to time constraints. Therefore, the validity of the framework was assessed using three methods as outlined in the following sections.

### **6.3.1 Previously validated frameworks**

The literature provides plenty of validated, useful information and frameworks that helps researchers to better create and design frameworks. The author reviewed the literature to understand and utilize these frameworks and to ensure that his framework components for implementing six sigma are based on previously validated frameworks. A wide literature review was utilised to build this framework, steps were adopted and /or modified from related previous frameworks which had already been validated, see section 6.2.2. This way ensures that the framework components are supported by the research literature.

### **6.3.2 Panel of experts**

The use of expert panel is frequently recommended by authors of research methods in order to maximize the validity of the research [186]. This approach was utilized to absorb expert's opinions of and get feedback / comments about the framework. Three academic experts in six sigma were interviewed to discuss why and how the framework was developed and how it can be implemented, also if there is any shortage or drawback in the framework. These experts were those the researcher met during the six sigma training course that he had. The interview with these experts was unstructured and revolved around the following topics:

- The importance of the framework to LMCs
- The development of all the framework phases and components
- The ease of understanding, logic, or flow of the framework
- The implementation process of the framework
- Overall usefulness of the framework in terms of applicability
- Comment on areas considered to be included/improved/ removed

Before holding the meeting, a copy of the framework was sent to all the participating experts in order to carefully read it, and then a meeting with the experts was held to discuss the above mentioned topics about the framework. Generally, the outcomes of the meeting showed an overall positive feedback. The experts expressed their positive opinion on the framework in terms of its components, benefits and coverage of an area that is under-investigated; they were very satisfied with the logic of developing the framework based on existing concepts.

The experts agreed that the framework has a good level of coverage of the related issues to the implementation of six sigma, it was understood that it adopted the excellence models

criteria. Overall, the experts confirmed that the framework presented a useful tool for raising the awareness and understanding of six sigma implementation. In addition, they gave useful comments on the overall framework and its components, as well as its applicability and it how could be improved. One particularly useful piece of feedback was the suggestion that the process of implementing the framework should be clearly explained. This feedback was addressed in the revised framework where some changes were made or extra details added to the phases including the description sections number 6.2.2.2 and 6.2.2.4.

### **6.3.3 An assessment by potential users**

The framework was assessed in four potential user companies in Libya by conducting unstructured interviews by telephone. The participating interviewees were those who had already taken part in the previous interview stage regarding the six sigma barriers. The reason behind that those interviewees already had an idea about the research and also they showed an interest to participate in any further interviews, this made it easier for the researcher to reach them without any complications. This approach is recommended by Creswell [69] for the assessment of the external validity of research findings. Lincoln and Guba [187] described this method as “member checking”, referring to participants of a study as members of it, and considered it as a very important technique for establishing validity.

Before conducting the interview, the researcher sent a copy of the proposed framework attached with a covering letter and an acceptance form (see appendix 13 & 14) to the participants in order to review the framework before conducting the main interview and they were given three weeks for reviewing. After ten days the researcher sent a reminder to the participants, then the main interviews were conducted after three weeks as agreed, all interviews were conducted on the same day; each interview lasted for about 30 minutes.

The same discussion topics as in the academic expert interview were discussed but this time from a practitioner view. The feedback on the proposed framework was very positive, all stated that the framework is well structured with a very good logic; one of the interviewees described the framework as very interesting and expressed his interest to recommend it for implementing in his company. The interviewees also stated that the framework emphasises the implementation factors that are relevant to six sigma, such as barriers, success factors and methodology. Overall, the interviewees were happy with the framework as they said it has presented a good approach to the whole process in general. However, their inquiries were

mostly about the estimated budget for the project implementation, also about the training providers as there is a lack of local six sigma training providers. Another important addition suggested from these interviews was the project implementation time line, which was considered afterwards. All the suggestions and comments from the interview processes were integrated in the framework to make a few minor amendments in sections 6.2.2.3 and 6.2.2.4 in the description of the framework.

## **Chapter Seven**

### **7 Conclusion and Recommendations**

#### **7.0 Introduction**

This research has studied the barriers and difficulties that affect the adoption and implementation of six sigma as well as the implementation frameworks. It aimed to investigate and identify such barriers that affect six sigma adoption in the Libyan manufacturing companies, and then using these findings to develop an implementation framework to be used in these companies.

The research methodology adopted in this study was mixed method methodology by using a survey starting by conducting interviews to collect qualitative data and followed by the development of a questionnaire to obtain quantitative data. This mixed data collection method is known as ‘the exploratory sequential design’; there is a broad consensus that mixing different kinds of methods can strengthen a research. The required data was collected to achieve the aim and objectives of the research through two main stages; secondary data collection using a wide literature review to understand the six sigma technique, its barriers and success factors, in addition to its implementation models and frameworks. Primary data collection using semi-structured interviews and questionnaires to investigate and identify the barriers behind the lack of six sigma use in LMCs. Using the obtained findings as well as a review of empirical studies on six sigma implementation frameworks and models, an implementation framework of six sigma has been developed and designed for LMCs.

This chapter indicates whether or not the aim and objectives of the research have been met, present the contribution to knowledge, limitations, and conclusion of the research findings, and also offer recommendations for practical and future work.

## **7.1 Meeting the aim and objectives**

After defining the research aim, the objectives of this research were set as the following:

- i. Review the six sigma approach in order to understand its positive points and therefore the possibility of benefiting from it.
- ii. Review the relevant literature covering the area of six sigma with emphasis on the barriers and reasons that impede the its adoption as well as the critical factors affecting its successful implementation in manufacturing companies.
- iii. Review of the Libyan manufacturing companies and their environmental work
- iv. Develop an interview to be conducted in Libyan manufacturing companies to find out the reasons and barriers behind the lack of six sigma and use these findings to help in designing the questionnaire questions.
- v. Develop a questionnaire and distribute it in the Libyan manufacturing companies to identify the reasons and barriers behind the lack of six sigma in this sector.
- vi. Analyse, investigate and interpret the data collected from the interview, questionnaire, and the literature review to develop an implementation framework of six sigma and recommendations to help the Libyan manufacturing companies to adopt six sigma as a solution to promote the level of manufacturing engineering and to keep pace with the global development in this area.
- vii. Recommendations and future work will be considered based upon a critical evaluation of the developed framework, and the results from the research.

By referring to the research flow chart shown in figure 1.3, it is clear to see that the aim and objectives of this research have been met. Wide and extensive studies and literature about six sigma have been reviewed. The following aspects have been covered in chapter two; the history of six sigma, what is six sigma, six sigma success and benefits, six sigma success factors and six sigma frameworks. In addition to a review of empirical studies on six sigma

and frameworks and models, this gave the researcher a comprehensive knowledge about six sigma and helped the researcher to achieve the aim of his research. Chapter two also covered an overview of the Libyan manufacturing environment which provides some useful information about the geographical location of Libya, Libyan society and culture, Libyan economy, Libyan organizations and management systems, and the Libyan manufacturing industry. This helped the researcher to understand the aspects and features of the companies under investigation.

The mixed method methodology was chosen for data collection for this research starting by conducting interviews to collect qualitative data and followed by the development of a questionnaire to obtain quantitative data. The interview questions were mainly generated from the literature review and were focused on the potential reasons and barriers behind the lack of six sigma use. The main targeting interviewees were those who are responsible for quality management systems in their firms, and also managers who are responsible for decision making, such as executives and chairmen. Once interviews were conducted and analysed, the data was used, together with the outcomes of the literature review, to develop the questionnaire for distribution to LMCs in order to obtain the quantitative data. In this stage, data was obtained by using a questionnaire survey method as the main quantitative tool. The reason for selecting a questionnaire for collecting quantitative data is that it allows the researcher to obtain a large amount of data from a large number of participants within a short period. The questionnaire was very carefully designed with regard to its structure, content, wording and format. Questions were generated from the six sigma literature review as the main source, with additional questions adopted and modified from other studies, which were conducted within the same environment (Libyan manufacturing industry). In addition, the interview findings were highly considered in developing the questionnaire. The main question type chosen for this survey was closed-ended, however, a few open-ended questions were also used in the form of “other (please specify)”. A five-point Likert scale was also widely used in the questionnaire. The questionnaire was translated into Arabic language as the spoken language in Libya, and pilot tested in two stages to guarantee that it was appropriately designed and all its contents were clear. Firstly, it was reviewed and checked by academic researchers and then tested in LMCs which were the targeted population. Finally, 150 self-administrated questionnaires were distributed to LMCs and 96 usable questionnaires were collected, giving a response rate of 64%. This data was then systematically analysed to identify the barriers to the six sigma implementation in LMCs.

Upon that, an implementation framework of six sigma was built and designed for LMCs based on previous quality and six sigma initiatives and incorporating unique phases and stages for LMCs taking into consideration the collected data about these companies.

## **7.2 Contribution to knowledge**

This research provides the following contribution to the existing knowledge

- This research is the leading study in the area of six sigma in the Libyan manufacturing sector; consequently, its findings and outcomes are an original contribution to the existing knowledge.
- This research identified the barriers behind the lack of six sigma in LMCs, as a result its findings and outcomes are of great value to Libyan manufacturing companies that are interested in adopting six sigma, in terms of providing them with guideline methodology, and effective recommendations for its successful implementation. This will also form a valued database to the Libyan government, principally to the ministry of industry.
- The results and outcomes of this research contribute to knowledge by offering new suggested directions for further work to extend the literature of six sigma, and more specifically provide data analysis, which assesses the implementation of six sigma in the Libyan manufacturing sector.

## **7.3 Conclusion of the study**

This section presents an overview of the main research findings, which have been presented in chapters Four, Five, and Six.

As mentioned earlier, the aim of this research was to investigate and identify the barriers behind the lack of six sigma adoption in the Libyan manufacturing companies and then develop a framework for its implementation. The investigations started by conducting interviews and the findings from the interviews showed that none of the LMCs is currently implementing six sigma. The findings also showed that LMCs encounter some barriers that are impeding them from adopting this technique. With a difference in terms of their significance, these barriers were identified, and placed in descending order according to their

importance, namely: “Lack of top management commitment”, “Lack of training”, “Lack of knowledge about six sigma”, and “Culture effect”. The findings also showed that some barriers which, were found in previous studies of six sigma implementation were not considered as barriers to LMCs but can, in fact, be considered as success factors or enablers for six sigma adoption. These factors were identified as: “sufficiency of time and financial resources”; “customers unsatisfied”; “good communication between all departments in the company”; “we are certain about its results and benefits to our company and unhappy with the current quality system”. These results suggest that LMCs face fewer barriers to adopting six sigma than many well-established global companies operating in other countries and could take advantage of these successful factors by developing and implementing a six sigma framework to improve their product quality and competitiveness.

The second stage of the investigation was performed by conducting a questionnaire to obtain quantitative data. The questionnaire findings also revealed that none of the LMCs is currently implementing six sigma or has ever implemented it. However, the results showed that quality control is the most common implemented technique in LMCs followed by ISO 9001, and then TQM. Furthermore, it revealed that some surveyed companies have no quality system implemented. These findings confirm what the researcher mentioned in chapter two, section 2.2.6.3, that LMCs suffer from a lack of implementing modern quality management systems and contemporary techniques and tools such as six sigma. It also supports the researcher’s statement in chapter one *“To date there is no evidence of the adoption of six sigma in the Libyan manufacturing industry”*

With regards to the barriers that face LMCs and impede them from adopting six sigma, the questionnaire findings revealed that only six key barriers are facing LMCs to the adoption of six sigma. The highest ranked barrier was “lack of six sigma training” and this was further supported by “the lack of six sigma expertise and specialists in the companies”. It was also clear that there is a “lack of awareness and knowledge of six sigma”, with many respondents having “never heard of the technique”. Other barriers that scored highly were “a lack of commitment to six sigma from top management” within the companies and more generally a “resistance to change from the organisations and their employees”.

The questionnaire findings also showed that nine factors out of fifteen are under the Mean average score of 3, this means that respondents disagreed with these statements, in other



words, these factors cannot be considered as barriers to LMCs, but they could, in fact, be considered as success factors or enablers for six sigma adoption. For example, respondents agreed that they are not happy with their current quality system and that their customers are not satisfied with the quality of the products they receive. The results also suggest that there is reason and relevance to implement six sigma in LMCs and that the necessary resources such as time and money as well as good interdepartmental communication are in place to do so.

These findings support the previously reported interview outcome (interview stage findings), with a slight difference in the order, and have also met one of the most important objectives in this research, which is to identify the reasons and barriers behind the lack of six sigma implementation in LMCs.

Upon these findings, and with reviewing a wide and comprehensive literature of six sigma, a six sigma implementation framework was designed and built for LMCs to achieve and meet another aim of this research. The framework was carefully designed, developed and assessed. The developed framework is clear and can be understood by all levels of managers and workers in a company. It offers guiding information on how six sigma implementation can begin by providing a valuable insight into the practice of six sigma. The framework serves as a platform which can enable manufacturing companies identify the gap in their implementation efforts, focus attention on areas for improvement and assess the benefits of six sigma.

#### **7.4 Limitations of the study**

Although this research has achieved its aim and objectives, as with any other studies, it is subject to some limitations, which can be summarised as follows:

- The sample was only limited to medium and large LMCs; therefore, the findings cannot be generalised to small manufacturing companies or other industries such as services.
- The surveyed companies do not entirely represent all LMCs in Libya, as there were a few cities, which could not be reached due to their security situation, and they were not safe for the researcher to reach them.
- Finally, as the researcher is a PhD student, so the allocated time was limited and restricted. Therefore, the allocated time is considered as one of the limitations of the study. If the

researcher had more time, he might have implemented the framework in one of LMCs to get a practical assessment.

## **7.5 Recommendations**

Based on the overall findings of this study, some recommendations for LMCs are presented as follows:

### **7.5.1 Practical recommendations**

A number of practical recommendations, which could be important to LMCs in implementing six sigma are given. The following are the main recommendations provided:

- The six sigma technique is obviously a new concept in LMCs and requires knowledge and skills. Therefore, LMCs should apply more emphasis on educational and training programmes in six sigma to reduce the problem of the lack of expertise and to ensure that all employees have a basic knowledge of the process involved; this should be continuously and equally given to all levels of the employees in the company.
- Responsibility for implementing six sigma is not allocated in one department or on one person in the company. Therefore, managers should make sure that all the employees at different levels are fully involved and committed to six sigma
- Top management should be fully committed to the six sigma programme. This can be reflected on; clear strategies and goals for implementing the six sigma, a plan for the implementation process, a schedule for the budget, a clear definition of all necessary resources, and a plan for training employees.
- A culture and behavioural change at all levels of the company, especially for top managers, is vital and should be made before the starting of the six sigma journey.
- A focus on customer satisfaction is an important factor in six sigma; consequently, LMCs should pay more attention on how to satisfy their customers by understanding their needs and expectations.
- The Libyan government could play a big role in building a quality environment by emphasising the importance of six sigma and all quality programmes for the whole

country, this can be achieved by establishing an annual award for six sigma and quality systems. This will serve many purposes, such as reassuring continuous improvement, raising awareness of six sigma and eliminating the fear of change.

### **7.5.2 Recommendations for future work**

Finally, the findings of this research show that LMCs have a lack of use and awareness of six sigma, thus, all barriers to six sigma in LMCs and the study limitations could set an agenda for future work. The following are the most recommended future work by the researcher:

- This study and its findings was limited to medium and large Libyan manufacturing companies, thus, further research could be conducted with different types and sizes industry. This would extend the findings of the current study and contribute towards a wider generalisation.
- Research on barriers in other Libyan sectors such as services should be conducted to compare if the barriers are the same or different.
- Further research is required to explore the role of top management, in order to find out why there is a lack of commitment and support for six sigma and quality initiatives.
- A benchmarking study could be done to compare the current situation of Libyan manufacturing companies with similar companies in other developing countries. It could be useful to learn from the experience of each other, and to explore whether the results of this study also apply to other countries.
- The proposed implementation framework in this study provides an opportunity for further empirical studies into the possibility of applying this framework in one of the LMCs in order to be practically evaluated and assessed.
- Further studies should be conducted to compare six sigma in other developed countries in order to learn from their best practices.

It is this researcher's hope that this study will inspire and encourage future researchers to extend the work in this important area of interest to other Libyan sectors and/or other developing countries, in order to enable his findings to be more widely compared and evaluated.

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## **Appendices**

### **Appendix 1: Interview covering letter**

**Dear Interviewee**

I'm a PhD student at the faculty of engineering and environment in Northumbria University at Newcastle UK. One of my research objectives is to identify the reasons and barriers behind the lack of six sigma use in Libyan manufacturing companies.

I have selected your company as a part of my research, so your participation is very important in order to achieve my goal. This interview is completely anonymous and your identity will not be marked on. The data gathered for this research will be for the purpose of my academic studies only. Also the results of my studies might be useful for your company.

I would be very grateful if you could spare some time to conduct this interview

Thank you very much for taking part in this research

**Osama Elgadi**

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## Appendix 2: Interview covering letter (Arabic version)

السيد المحترم....

بعد التحية...

هذه الاسئلة هي جزء من الدراسة العملية التي اقوم بها الان كطالب دراسات عليا لنيل درجة الدكتوراة من جامعة نورت امبريا – نيوكاسل ببريطانيا.وهي جزء من دراستي تتعلق بتحديد الاسباب والعوائق التي تؤثر في تطبيق نظام 6 سيجما(Six sigma) في الشركات الصناعية في ليبيا. وحيث انه قد تم اختيار مؤسستكم كحالة دراسية لهذا البحث. نأمل تعاونكم ومساهمتكم في الاجابة على هذه الاسئلة. علما بان كل المعلومات التي سيتم تجميعها سوف تستخدم وتحلل اكاديميا لتحقيق الغرض المطلوب من هذا البحث.بالاضافة الى امكانية الاستفادة من النتائج في تطوير وتحسين الجودة في مؤسستكم.

أننا نقدر عاليا تخصيص جزء من وقتكم الثمين بمشاركتكم الفاعلة في الاجابة على هذه الاسئلة وبكل شفافية وشعور بالمسؤولية حيال مؤسستكم والبحث العلمي في آن واحد.

شكرا على حسن اهتمامكم ودعمكم.....والسلام عليكم ورحمة الله وبركاته

باحث/ أسامة بنور القاضي

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[osama.elgadi@northumbria.ac.uk](mailto:osama.elgadi@northumbria.ac.uk)

### Appendix 3: Interview questions

1- Can you tell me your position and how long have you been employed in your company, what type of industry does your company operate in?

1- هل من الممكن اخبارنا عن منصبك وكم المدة التي قضيتها في شركتكم حتى الان و ماهي الصناعة التي تقوم بها شركتكم؟

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2-Have you ever heard of the term six sigma? What is your knowledge about six sigma?

2- هل سمعت من قبل بمصطلح 6 سيجما ( six sigma ) ؟ ماهي معرفتك او معلوماتك عن 6 سيجما؟

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3-Has your company ever implemented six sigma? If no, why?

3- هل قامت شركتكم بتطبيق 6 سيجما في اي وقت مضى ؟ اذا كانت الاجابة لا لماذا؟

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4-Do you think six sigma is a complicated technique and are you uncertain about its results and benefits?

4-هل تعتقد ان 6 سيجما تقنية معقدة وغير واثق من نتائجها وفوائدها؟

5-What kind of quality management systems has your company used? Are you satisfied with the current system, and feel that there no need for six sigma?

5-ما هو نظام ادارة الجودة التي تستخدمه شركتكم حاليا؟ هل انتم راضون بالنظام الحالي ولستم بحاجة الى تطبيق سيجما؟

6-Does your company run any kind of training related to six sigma?

6-هل تقوم شركتكم باجراء دورات تدريبية متعلقة ب 6 سيجما؟

7-Are there any six sigma trained professionals in your company?

7-هل لديكم متدربين مهنيين في 6 سيجما؟

8-Are there six sigma training providers available in Libya?

8-هل يوجد في ليبيا مراكز او شركات تقوم بتوفير دورات تدريبية متعلقة ب 6 سيجما؟

9-Does your company have sufficient financial resources to implement six sigma?

9-هل لدى شركتكم المصادر المالية الكافية لتطبيق 6 سيجما؟

10-Do you think introducing six sigma to your company is too costly?

10-هل تعتقد ان تطبيق 6 سيجما مكلف جدا لشركتكم؟

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11-Do you have sufficient time to implement six sigma?

11-هل لديكم الوقت الكافي لتطبيق 6 سيجما؟

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12-Is there a good communication between all departments in the company?

12-هل توجد نظم اتصالات جيدة بين مختلف الاقسام في شركتكم؟

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13-Is there a culture change effect (resistance to change) for introducing any new technology or technique?

13-هل توجد ثقافة المقاومة او اي الاعتراض من قبل البعض في الشركة عند تقديم اي نوع جديد من التكنولوجيا او التقنيات؟

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14-Does the top management show no interest for introducing six sigma, in other words is there lack of top management commitment?

14-هل ان الادارة العليا في الشركة غير مهتمة بتقديم 6 سيجما للشركة؟

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15-Are the company's customers satisfied? Are they happy with the quality of the products?

15-هل زبائن الشركة راضيين عن خدمات الشركة؟ هل هم ممتنين لجودة المنتجات؟

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16-What are other reasons or barriers facing your company to start implementing six sigma?

16-ماهي الاسباب او العوائق الاخرى التي تواجه شركتكم في ادخال وتطبيق 6 سيجما؟



17-Do you think that your company is interested in implementing six sigma in the short term?

17-هل تعتقد ان شركتكم لديها الرغبة في ادخال وتطبيق 6 سيجما في المدى القريب؟

Could you please write down your contact details

الرجاء كتابة معلومات الاتصال بك

E-mail:.....

phone number:.....

Thank you for your co-operation

شكرا لحسن تعاونكم

### A glance about six sigma

### نبذة بسيطة عن 6 سيجما

#### ماهي 6 سيجما (six sigma)؟

6 سيجما هي عملية أو إستراتيجية تمكن المنشآت من التحسن بصورة كبيرة فيما يخص عملياتها الأساسية وهيكلها من خلال تصميم ومراقبة أنشطة الأعمال اليومية بحيث يتم تقليل الفاقد واستهلاك المصادر (الوقت – الطاقات الذهنية – الطاقات المادية) وفي نفس الوقت تلبية احتياجات العميل وتحقيق القناعة لديه، وبدل مبدأ 6 سيجما على أن المنشأة تقدم خدمات أو سلعا خالية من العيوب تقريبا لأن نسبة العيوب في 6 سيجما لايتجاوز 3.4 عيب لكل مليون فرصة، أي أن نسبة كفاءة وفاعلية العمليات تصل إلى 99.99966%. وتعتبر 6 سيجما طريقة منضبطة لجمع البيانات، والتحليل الإحصائي لتحديد مصادر الأخطاء وسبل القضاء عليها خلاصة الأمر أن فكرة 6 سيجما تكمن في أنه إذا كانت المنشأة قادرة على قياس عدد العيوب الموجودة في عملية ما فإنها تستطيع بطريقة علمية أن تزيل تلك العيوب وتقترب من نقطة خلو من العيوب.

#### مزايا 6 سيجما:-

- المساعدة في فهم وإدارة احتياجات العملاء.
- التقليل من شكاوي العملاء وتحقيق أقصى قدر من رضاهم.
- اعتماد الدقة في تحليل البيانات للحد من الخلل في العملية.
- التطور السريع ومواصلة تحسين لعملية الإدارة.
- التقليل من التكاليف اللازمة لاجراء العمليات.
- الحد من التغيرات والتقلبات في العمليات وبالتالي التقليل من العيوب والاختفاء.

- رفع معدلات الكفاءة بين الموظفين.
- التدريب جزء لا يتجزأ من نظام الإدارة.
- الترتيب والتنظيم عملية أساسية لتحقيق المتطلبات اللازمة.

#### **Appendix 4: Pilot study covering letter (stage 1)**

**Dear Colleague**

This questionnaire is a part of my PhD research. I'm now conducting a pilot study among PhD students at Northumbria University. One of my research objectives is to identify the reasons and barriers behind the lack of six sigma use in Libyan manufacturing companies.

The main aim of this pilot study is to identify how much time the questionnaire takes to be answered, whether the instructions are clear or not and if there is any ambiguity in the questions; your feedback is really appreciated.

I would be very grateful if you could give me some time to complete this questionnaire

**Please be aware to time how much it takes you to complete this questionnaire and write it down at the end of the questionnaire.**

Thank you very much for taking part in this research

**Osama Elgadi**

**209 Wynne Jones Building**

**Mobile number: 00447459356974**

**Email: [osyma75@yahoo.com](mailto:osyma75@yahoo.com)**

**[osama.elgadi@northumbria.ac.uk](mailto:osama.elgadi@northumbria.ac.uk)**

## **Appendix 5: Pilot study covering letter (stage 2)**

**Dear participant**

I'm a PhD student in the Faculty of Engineering and Environment at Northumbria University in Newcastle, UK. One of my research objectives is to identify the reasons and barriers behind the lack of six sigma use in Libyan manufacturing companies.

I have selected your company as a part of my research, so your participation is very important in order to achieve my goal. This questionnaire is completely anonymous and your identity will not be marked on it. The data gathered for this research will be for the purpose of my academic studies only. Also the results of my studies might be useful for your company.

I would be very grateful if you could spare some time to complete this questionnaire

Thank you very much for taking part in this research

**Osama Elgadi**

**Mobile number: 00447459356974**

Email: [osyma75@yahoo.com](mailto:osyma75@yahoo.com)  
[osama.elgadi@northumbria.ac.uk](mailto:osama.elgadi@northumbria.ac.uk)

## **Appendix 6: Research questionnaire in the pilot study stage 1**

### **Introduction**

#### **About six sigma**

Six sigma is a quality improvement technique, which was originally developed by Motorola in 1987, to target a rigid goal of increasing product quality and reducing defects to 3.4 per million opportunities. The approach was introduced in response to the threat from Japanese competitors who had lower defective rates. The major objective of six sigma is to improve customer satisfaction

#### **Six Sigma Benefits**

The six sigma technique has been perhaps the most successful business improvement strategy in the last few decades. The application of six sigma goes beyond manufacturing to services, healthcare, public sectors and government. A ‘big dollar impact’ is one of the key reasons for the success of six sigma implementation. However, this is not the only reason behind implementing it, there are other key reasons for the benefits of six sigma implementation as follows:-

- ✓ Reduction of defects
- ✓ Reduction of cycle time
- ✓ Reduction of process variability
- ✓ Reduction of customer complaints
- ✓ Reduction of costs
- ✓ Productivity increase
- ✓ Profit increase
- ✓ Improved attitude of top management and employees towards quality and problem solving

---

## Instructions for participants

This questionnaire is designed according to a strategy and depends on following some instructions, so please read them carefully before answering:

- Please fill the required data according to the order in the questionnaire, i.e. Q1 followed by Q2 and so on.
- Your answers on this questionnaire are not considered as personal information as your name is not required. So we hope that your answers will be truthful, and to the best of your knowledge.
- Please read the questions carefully to understand them before answering them, in order to give the best possible results.
- Please leave the answer blank if you do not know the correct answer.
- You can tick more than one box per question if appropriate.

### Section one: - General information

Please fill in the blanks or tick in a box where it is appropriate for each question below:-

1- Your age in years:

Less than 20 ☐      20-29 ☐      30-39 ☐      40-49 ☐      50 and over ☐

2- Your position in the company:

Top manager ☐      Middle manager ☐      Supervisor ☐      Employee ☐

Other ☐ please specify.....

3- Your educational level:

Less than secondary ☐      Secondary ☐      Diploma ☐      Bachelor degree ☐      Master degree ☐

PhD degree ☐      Other ☐ please specify.....

4- Experience in years:

Less than 5 ☐      5-10 ☐      11-15 ☐      16-20 ☐      More than 20 ☐

5- Please indicate the number of employees in your company

Less than 100 ☐      100-499 ☐      500 and more ☐

6- What is the ownership type of your company:-

Public ☐ Private ☐ Joint venture ☐

Other ☐ please specify.....

7- What type of industry does your company operate in?

Food industry ☐ Electrical and Electronics industry ☐ Mechanical industry ☐

Chemical industry ☐ Textile and Furniture industry ☐ Building materials industry ☐

Other ☐ please specify.....

## Section two: - Quality system and six sigma background

1- What is the current quality system in your company:-

ISO 9001 ☐ TQM ☐ Quality control ☐ Six sigma ☐ Kaizen ☐ Lean manufacturing ☐

None ☐ Other ☐, please specify.....

2- Did your company previously implement any kind of quality systems? Yes ☐ No ☐

If yes, what kind of quality system did your company use:-

ISO 9001 ☐ TQM ☐ Quality control ☐ Six sigma ☐ Kaizen ☐ Lean manufacturing ☐

None ☐ Other ☐, please specify.....

3- Have you ever heard of the term six sigma before undertaking this questionnaire?

Yes ☐ No ☐

If yes, Please rate your knowledge with six sigma. 1 2 3 4 5  
☐ ☐ ☐ ☐ ☐  
Low High

4- Does your company run any kind of quality training for employees?

Yes ☐ No ☐ I do not know ☐

If yes, what type of quality training is run at your company:-

ISO 9001 ☐ TQM ☐ Quality control ☐ Six sigma ☐ Kaizen ☐ Lean manufacturing ☐

None ☐ Other ☐, please specify.....

5- If there was a training course designed exclusively for six sigma, would you be interested in taking part in it? Yes ☐ No ☐

6- Do you wish that your company would implement six sigma in the short term? Yes ☐ No ☐

7- In your opinion, the decision whether or not to introduce six sigma to your company will be taken by:

Top management ☐ Middle management ☐ I do not know ☐

Other ☐ please specify.....

**Section three:** - In your opinion, what are the factors affecting the adoption of six sigma in your company? Please tick the appropriate choice for each item listed in the following table:-

N	Factors affecting the adoption of six sigma	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1	Top management commitment	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	It is unknown to us	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	Lack of knowledge and awareness about six sigma in your company	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4	Lack of six sigma expertise and specialists in your company	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5	six sigma is a complicated technique and we are uncertain about its results and benefits	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6	There is a good communication between all departments in the company	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7	Lack of financial resources	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8	Lack of six sigma training courses	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9	Culture effect( resistance to change)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10	Insufficient time for implementation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Company's customers are satisfied and					

11	happy with the quality of the products	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12	We are happy with the current quality system	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Other factors you would like to mention.....

.....

**Section four:** - Please tick the box that best reflects your answer for each factor in the following table:-

1	Factor 1: Top management commitment	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1.1	Top management have a lack of knowledge about six sigma	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.2	Top management do not pay attention to introducing six sigma	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.3	Top management have no clear quality vision	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.4	Top management do not allocate adequate resources and time for quality improvement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.5	There are wrong people in the wrong positions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.6	There is a lack of leadership and effective leaders in your company	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	Factor 2: Training courses	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
2.1	There are no six sigma training programmes in your company	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.2	There is a lack of six sigma trained professionals in your company	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.3	There is a lack of six sigma training providers in Libya	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.4	In general, there is a lack of quality system					



	training programmes in your company	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.5	There is no training department in your company.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.6	The training managers are not effective and capable	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	Factor 3:Lack of knowledge and awareness about six sigma	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
3.1	Most employees and managers in your company have a lack of knowledge about six sigma	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.2	There is a lack of information and awareness about six sigma in your company	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.3	There is a lack of six sigma conferences, seminars, workshops and publications	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.4	There is a lack of local consultants and expertise in six sigma	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.5	There is a lack of governmental bodies who support , make knowledge and awareness about six sigma	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4	Factor 4: Culture effect ( resistance to change)	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
4.1	In general, there is no desire to change	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.2	The culture of resistance to change is spread throughout the company	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.3	There are difficulties in accepting new techniques & approaches in your company	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.4	There is a lack of knowledge about the advantages and benefits of the new techniques	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.5	People believe that a new technique will threaten their positions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.6	People believe that a new technique will increase the workload and make it too complicated	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.7	There is an unwillingness to change from the existing system	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

We would appreciate any comments or suggestions you may care to make about any issue mentioned in the questionnaire. You may use the space below and overleaf to do this.

This image shows a single sheet of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Phone: 00447459356974  
Or email:-

## **Appendix 7: Research questionnaire in the pilot study stage 2**

### **Introduction**

#### **About six sigma**

Six sigma is a quality improvement technique, which was originally developed by Motorola in 1987, to target a rigid goal of increasing product quality and reducing defects to 3.4 per million opportunities. The approach was introduced in response to the threat from Japanese competitors who had lower defective rates. The major objective of six sigma is to improve customer satisfaction

#### **Six Sigma Benefits**

The six sigma technique has been perhaps the most successful business improvement strategy in the last few decades. The application of six sigma goes beyond manufacturing to services, healthcare, public sectors and government. A “big dollar impact” is one of the key reasons for the success of six sigma implementation. However, this is not the only reason behind implementing it, there are other key reasons for the benefits of six sigma implementation as follows:-

- ✓ Reduction of defects
  - ✓ Reduction of cycle time
  - ✓ Reduction of process variability
  - ✓ Reduction of customer complaints
  - ✓ Reduction of costs
  - ✓ Productivity increase
  - ✓ Profit increase
  - ✓ Improved attitude of top management and employees towards quality and problem solving
- 

### **Instructions for participants**

This questionnaire is designed according to a strategy and depends on following some instructions, so please read them carefully before answering:

- Please fill the required data according to the order in the questionnaire, i.e. Q1 followed by Q2 and so on.

- Your answers on this questionnaire are not considered as personal information as your name is not required. So we hope that your answers will be truthful, and to the best of your knowledge.
- Please read the questions carefully to understand them before answering them, in order to give the best possible results.
- Please leave the answer blank if you do not know the correct answer.
- You can tick more than one box per question if appropriate.

### **Section one: - General information**

Please fill in the blanks or tick in a box where it is appropriate for each question below:-

1- Your age in years:

Less than 20 ☐      20-29 ☐      30-39 ☐      40-49 ☐      50 and over ☐

2-Your position in the company:

Top manager ☐      Middle manager ☐      Supervisor ☐      Employee ☐

Other ☐ please specify.....

3-Your educational level:

Less than secondary ☐      Secondary ☐      Diploma ☐      Bachelor degree ☐      Master degree ☐

PhD degree ☐      Other ☐ please specify.....

4-Experience in years:

Less than 5 ☐      5-10 ☐      11-15 ☐      16-20 ☐      More than 20 ☐

5-Please indicate the number of employees in your company

Less than 100 ☐      100-499 ☐      500 and more ☐

6-What is the ownership type of your company:-

Public ☐      Private ☐      Joint venture ☐

Other ☐ please specify.....

7-What type of industry does your company operate in?

Food industry ☐      Electrical and Electronics industry ☐      Mechanical industry ☐

Chemical industry ☐ Textile and Furniture industry ☐ Building materials industry ☐

Other ☐ please specify.....

## Section two: - Quality system and six sigma background

1-What is the current quality system in your company:-

ISO 9001 ☐ TQM ☐ Quality control ☐ Six sigma ☐ Kaizen ☐ Lean manufacturing ☐

None ☐ Other ☐, please specify.....

2-Did your company previously implement any kind of quality systems? Yes ☐ No ☐

If yes, what kind of quality system did your company use:-

ISO 9001 ☐ TQM ☐ Quality control ☐ Six sigma ☐ Kaizen ☐ Lean manufacturing ☐

None ☐ Other ☐, please specify.....

3-Have you ever heard of the term six sigma before undertaking this questionnaire?

Yes ☐ No ☐

If yes, Please rate your knowledge with six sigma. 1 2 3 4 5  
☐ ☐ ☐ ☐ ☐  
Low High

4-Does your company run any kind of quality training for employees?

Yes ☐ No ☐ I do not know ☐

If yes, what type of quality training is run at your company:-

ISO 9001 ☐ TQM ☐ Quality control ☐ Six sigma ☐ Kaizen ☐ Lean manufacturing ☐

None ☐ Other ☐, please specify.....

5-If there was a training course designed exclusively for six sigma, would you be interested in taking part in it? Yes ☐ No ☐ I do not know ☐

6-Do you wish that your company would implement six sigma in the short term?

Yes ☐ No ☐ I do not know ☐

7-In your opinion, the decision whether or not to introduce six sigma to your company will be taken by:

Top management ☐ Middle management ☐ I do not know ☐

Other ☐ please specify.....

**Section three:** - In your opinion, what are the factors impeding the adoption of six sigma in your company? Please tick the appropriate choice for each item listed in the following table:-

N	Factors impeding the adoption of six sigma	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1	Lack of top management commitment	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	It is unknown to us	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	Lack of knowledge and awareness about six sigma in your company	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4	Lack of six sigma expertise and specialists in your company	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5	six sigma is a complicated technique and we are uncertain about its results and benefits	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6	There is a good communication between all departments in the company	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7	Six sigma is too costly to your company	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8	Lack of financial resources	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9	Lack of six sigma training courses	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10	Culture effect( resistance to change)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11	Insufficient time for implementation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12	Company's customers are satisfied and happy with the quality of the products	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13	We are happy with the current quality system	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Other factors you would like to mention.....

.....

.....

.....

**Section four:** - Please tick the box that best reflects your answer for each factor in the following table:-

1	Factor 1: Top management commitment	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1.1	Top management have a lack of knowledge about six sigma	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.2	Top management do not pay attention to introducing six sigma	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.3	Top management have no clear quality vision	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.4	Top management do not allocate adequate resources and time for quality improvement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.5	There are wrong people in the wrong positions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.6	There is a lack of leadership and effective leaders in your company	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	Factor 2: Training courses	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
2.1	There are no six sigma training programmes in your company	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.2	There is a lack of six sigma trained professionals in your company	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.3	There is a lack of six sigma training providers in Libya	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.4	In general, there is a lack of quality system training programmes in your company	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

2.5	There is no training department in your company.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.6	The training managers are not effective and capable	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	Factor 3:Lack of knowledge and awareness about six sigma	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
3.1	Most employees and managers in your company have a lack of knowledge about six sigma	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.2	There is a lack of information and awareness about six sigma in your company	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.3	There is a lack of six sigma conferences, seminars, workshops and publications	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.4	There is a lack of local consultants and expertise in six sigma	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.5	There is a lack of governmental bodies who support , make knowledge and awareness about six sigma	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4	Factor 4: Culture effect ( resistance to change)	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
4.1	In general, there is no desire to change	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.2	The culture of resistance to change is spread throughout the company	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.3	There are difficulties in accepting new techniques & approaches in your company	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.4	There is a lack of knowledge about the advantages and benefits of the new techniques	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.5	People believe that a new technique will threaten their positions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.6	People believe that a new technique will increase the workload and make it too complicated	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.7	There is an unwillingness to change from the existing system	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



We would appreciate any comments or suggestions you may care to make about any issue mentioned in the questionnaire. You may use the space below and overleaf to do this.

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**osyma75@yahoo.com**

## Appendix 8: Research questionnaire in the pilot study stage 2 (Arabic version)

السيد المحترم....  
بعد التحية...

هذه الاسئلة هي جزء من الدراسة العملية التي اقوم بها الان كطالب دراسات عليا لنيل درجة الدكتوراة من جامعة نورت امبريا – نيوكاسل ببريطانيا.وهي جزء من دراستي تتعلق بتحديد الاسباب والعوائق التي تعيق ادخال و تطبيق نظام 6 سيجما(Six sigma) في الشركات الصناعية في ليبيا.  
وحيث انه قد تم اختيار مؤسستكم كحالة دراسية لهذا البحث. نأمل تعاونكم ومساهمتم في تعبئة الاستبيان المرفق. علما بان كل المعلومات التي سيتم تجميعها سوف تستخدم وتحلل اكاديميا لتحقيق الغرض المطلوب من هذا البحث.بالاضافة الى امكانية الاستفادة من النتائج في تطوير وتحسين الجودة في مؤسستكم.

أننا نقدر عاليا تخصيص جزء من وقتكم الثمين بمشاركتم الفاعلة في الاجابة على هذه الاسئلة وبكل شفافية وشعور بالمسؤولية حيال مؤسستكم والبحث العلمي في آن واحد.

شكرا على حسن اهتمامكم ودعمكم.....والسلام عليكم ورحمة الله وبركاته

باحث/ أسامة بنور القاضي

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## نبذة بسيطة عن 6 سيجما (Six Sigma)

### ماهي 6 سيجما (six sigma)؟

6 سيجما هي عملية أو إستراتيجية تمكن المنشآت من التحسن بصورة كبيرة فيما يخص عملياتها الأساسية وهيكلها من خلال تصميم ومراقبة أنشطة الأعمال اليومية بحيث يتم تقليل الفاقد واستهلاك المصادر (الوقت – الطاقات الذهنية – الطاقات المادية) وفي نفس الوقت تلبية احتياجات العميل وتحقيق القناعة لديه، وبدل مبدأ 6 سيجما على أن المنشأة تقدم خدمات أو سلعا خالية من العيوب تقريبا لأن نسبة العيوب في 6 سيجما لا يتجاوز 3.4 عيب لكل مليون فرصة، أي أن نسبة كفاءة وفاعلية العمليات تصل إلى 99.99966%. وتعتبر 6 سيجما طريقة منضبطة لجمع البيانات، والتحليل الإحصائي لتحديد مصادر الأخطاء وسبل القضاء عليها

خلاصة الأمر أن فكرة 6 سيجما تكمن في أنه إذا كانت المنشأة قادرة على قياس عدد العيوب الموجودة في عملية ما فإنها تستطيع بطريقة علمية أن تزيل تلك العيوب وتقترب من نقطة خلو من العيوب.

### مزايا 6 سيجما:- (six sigma)

- المساعدة في فهم وإدارة احتياجات العملاء.
- التقليل من شكاوي العملاء وتحقيق أقصى قدر من رضاهم.
- اعتماد الدقة في تحليل البيانات للحد من الخلل في العملية.
- التطور السريع ومواصلة تحسين لعملية الإدارة.
- التقليل من التكاليف اللازمة لاجراء العمليات.
- الحد من التغيرات والتقلبات في العمليات وبالتالي التقليل من العيوب والاختفاء.
- رفع معدلات الكفاءة بين الموظفين.
- التدريب جزء لا يتجزأ من نظام الإدارة.
- الترتيب والتنظيم عملية أساسية لتحقيق المتطلبات اللازمة

## تعليمات للمشاركين

- صُمِّمَ هذا الاستبيان وفقاً لمخطط يعتمد على تتبع التعليمات التالية، لذا يُرجى التمعن في قراءتها قبل الإجابة:
- الرجاء ملأ البيانات المطلوبة حسب ترتيبها في نموذج الاستبيان، مثال: سؤال 1 يتبعه سؤال 2.
  - إن إجاباتك في هذا النموذج ليست معلومات خاصة أو شخصية بما أنه لم يُطلب منك وضع اسمك، لذلك نأمل أن تكون إجاباتك حقيقية وبأتم المعرفة.
  - يرجى قراءة الأسئلة بتمعن لفهمها قبل الإجابة عليها من أجل الحصول على أفضل النتائج الممكنة.
  - يرجى ترك الإجابة فارغة إذا لم تعرف الإجابة الصحيحة.
  - يمكنك اختيار أكثر من إجابة في بعض الأسئلة إن استوجب الأمر.
- 

### الجزء الأول: معلومات عامة

يرجى ملأ الفراغات أو وضع علامة في المربعات ☐ أمام الإجابة المناسبة لكل سؤال:-

- 1- كم عمرك بالسنوات:
- ☐ أقل من 20      ☐ 29-20      ☐ 39-30      ☐ 49-40      ☐ 50 فأكثر

- 2- وظيفتك في الشركة:
- ☐ مدير عام      ☐ مدير إدارة وسطى      ☐ مشرف      ☐ موظف
- ☐ أخرى      الرجاء ذكرها .....

- 3- المستوى الدراسي:
- ☐ دون الثانوية      ☐ ثانوية      ☐ دبلوم      ☐ بكالوريوس      ☐ ماجستير
- ☐ دكتوراه      ☐ أخرى      الرجاء ذكرها .....

- 4- سنوات الخبرة:
- ☐ أقل من 5 سنوات      ☐ 10-5      ☐ 15-11      ☐ 20-16      ☐ أكثر من 20 سنة

- 5- يرجى ذكر عدد الموظفين بالشركة/مكان عملك:
- ☐ أقل من 100      ☐ 499-400      ☐ أكثر من 500

- 6- ما هي صفة ملكية الشركة/مكان عملك:
- ☐ عامة      ☐ خاصة      ☐ مشتركة
- ☐ أخرى      الرجاء ذكرها .....

- 7- ما هو المجال الصناعي الذي تشتغل فيه الشركة/مكان عملك؟
- ☐ الصناعات الغذائية      ☐ الصناعات الكهربائية والإلكترونية      ☐ الصناعات الميكانيكية
- ☐ الصناعات الكيماوية      ☐ صناعة النسيج والأثاث      ☐ مواد البناء

أخرى ☐ الرجاء ذكرها .....

## الجزء الثاني:- نظام الجودة وخلفية عن 6 سيجما

### 1- ما هو نظام الجودة الحالي بالشركة/مكان عملك:

أيزو 9001 ☐ TQM ☐ مراقبة جودة ☐ 6 سيجما ☐ Kaizen ☐  
Lean Manufacturing ☐ لا يوجد ☐

أخرى ☐ الرجاء ذكرها .....

### 2- هل سبق لشركتكم في الماضي ان طبقت أي نوع من أنظمة الجودة؟

لا ☐ نعم ☐

إن كانت الاجابة نعم، أي نوع من أنظمة الجودة التي استعملتها الشركة/مكان عملك:-

أيزو 9001 ☐ TQM ☐ مراقبة جودة ☐ 6 سيجما ☐ Kaizen ☐  
Lean Manufacturing ☐ لا يوجد ☐

أخرى ☐ الرجاء ذكرها .....

### 3- هل سبق لك أن سمعت عن 6 سيجما قبل هذا الاستبيان؟

لا ☐ نعم ☐

إذا كانت الاجابة نعم، يرجى تقييم معرفتك بـ 6 سيجما

1 2 3 4 5  
☐ ☐ ☐ ☐ ☐  
ضعيف عالي

### 4- هل تقوم شركتكم بأجراء دورات تدريبية على اي نوع من أنظمة الجودة لفائدة العاملين؟

نعم ☐ لا ☐ لا أعرف ☐

إن كانت الاجابة نعم، على اي نوع من أنظمة الجودة يجرى التدريب:-

أيزو 9001 ☐ TQM ☐ مراقبة جودة ☐ 6 سيجما ☐ Kaizen ☐  
Lean Manufacturing ☐ لا يوجد ☐

أخرى ☐ الرجاء ذكرها .....

### 5- إذا كانت هناك دورة تدريبية مصممة لـ 6 سيجما ، هل لديك الرغبة بالمشاركة فيها؟

نعم ☐ لا ☐ لا أعرف ☐

### 6- هل تتمنى ان تقوم شركتكم بتطبيق 6 سيجما في أقرب وقت؟

نعم ☐ لا ☐ لا أعرف ☐

### 7- حسب رأيك، من سيتخذ قرار إدخال أو عدم إدخال 6 سيجما إلى الشركة/مكان عملك:

الإدارة العليا ☐ الإدارة الوسطى ☐ لا أعرف ☐

أخرى ☐ الرجاء ذكرها .....

الجزء الثالث: - حسب رأيك ما هي العوامل التي تعيق تبني او تطبيق 6 سيجما بالشركة/مكان عملك ؟ يرجى وضع علامة أمام الاختيار المناسب لكل بند مذكور في الجدول التالي:-

رقم	العوامل التي تعيق تبني او تطبيق 6 سيجما	رفض بقوة	رفض	حياد	موافق	موافق بقوة
1	عدم التزام الإدارة العليا بالشركة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	غير معروفة عندنا	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	نقص المعرفة والتوعية بـ 6 سيجما في الشركة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4	عدم وجود خبراء ومختصين بـ 6 سيجما بالشركة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5	6 سيجما تقنية معقدة، ونحن غير متأكدين من نتائجها ومنافعها	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6	يوجد تواصل جيد بين إدارات وأقسام الشركة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7	6 سيجما مكلفة جدا للشركة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8	نقص الموارد المالية للشركة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9	عدم وجود دورات تدريبية خاصة بـ 6 سيجما	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10	تأثير الثقافة (مقاومة التغيير)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11	لا يوجد لدينا الوقت الكافي لتطبيق 6 سيجما	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12	زبائن الشركة راضون وسعداء بجودة المنتجات	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13	نحن سعداء بنظام الجودة الحالي	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

عوامل أخرى ترغب في ذكرها.....  
 .....  
 .....

الجزء الرابع:- يرجى وضع علامة أمام المربع الذي يعكس جيدا إجابتك لكل عامل في الجدول التالي:-

1	العامل 1: التزام الإدارة العليا	رفض بقوة	رفض	حياد	موافق	موافق بقوة
1.1	نقص المعرفة لدى الإدارة العليا بـ 6 سيجما	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.1	الإدارة العليا لا تهتم بإدخال 6 سيجما	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.1	الإدارة العليا لا تمتلك رؤية واضحة حول الجودة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.1	الإدارة العليا لا تخصص موارد ووقت كافي لتحسين الجودة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5.1	وجود أشخاص غير مناسبين في مناصب غير مناسبة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

6.1	نقص الروح القيادية والقادة الأكفاء في الشركة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	العامل 2: الدورات التدريبية	رفض بقوة	رفض	حياد	موافق	موافق بقوة
1.2	لا توجد برامج تدريب على 6 سيجما في الشركة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.2	عدم وجود موظفين مهنيين مدربين على 6 سيجما في الشركة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.2	عدم وجود شركات مختصة تقوم بالتدريب على 6 سيجما في ليبيا	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.2	عموما... عدم وجود برامج تدريب على أنظمة الجودة في الشركة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5.2	لا توجد إدارة تدريب في الشركة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6.2	مدراء التدريب في الشركة غير أكفاء أو قادرين	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	العامل 3: عدم المعرفة والتوعية بـ 6 سيجما في الشركة	رفض بقوة	رفض	حياد	موافق	موافق بقوة
1.3	أغلب المدراء والموظفين بالشركة تنقص لديهم المعرفة بـ 6 سيجما	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.3	عدم وجود معلومات وتوعية حول 6 سيجما بالشركة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.3	عدم وجود منتديات ومؤتمرات وورش عمل ومنشورات حول 6 سيجما	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.3	عدم وجود مستشارين وخبراء 6 سيجما محليين	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5.3	عدم وجود هيئات حكومية تدعم وتقوم بالتعريف والتوعية بـ 6 سيجما	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4	العامل 4: تأثير الثقافة (مقاومة التغيير)	رفض بقوة	رفض	حياد	موافق	موافق بقوة
1.4	لا توجد رغبة في التغيير بالشركة بصفة عامة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.4	ثقافة مقاومة التغيير منتشرة في الشركة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.4	توجد صعوبات في قبول تقنيات وانظمة جديدة في الشركة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.4	عدم وجود معرفة حول مزايا ومنافع التقنيات الجديدة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5.4	يعتقد الناس أن التقنية الجديدة سوف تهدد مناصبهم	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6.4	يعتقد الناس أن التقنية الجديدة سوف تزيد من ضغط العمل وسوف تجعله معقدا جدا	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7.4	لا توجد إرادة لتغيير النظام الحالي	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

نشكركم جزيلًا على تعاونكم في هذا الاستبيان

سوف نكون ممتنين لأي تعليقات أو اقتراحات منكم حول أي مسألة مذكورة في الاستبيان. يمكنك الكتابة في المساحة أدناه وفي ظهر الصفحة.





## **Appendix 9: Research questionnaire in the final study**

### **Introduction**

#### **About six sigma**

Six sigma is a quality improvement technique, which was originally developed by Motorola in 1987, to target a rigid goal of increasing product quality and reducing defects to 3.4 per million opportunities. The approach was introduced in response to the threat from Japanese competitors who had lower defective rates. The major objective of six sigma is to improve customer satisfaction

#### **Six Sigma Benefits**

The six sigma technique has been perhaps the most successful business improvement strategy in the last few decades. The application of six sigma goes beyond manufacturing to services, healthcare, public sectors and government. A “big dollar impact” is one of the key reasons for the success of six sigma implementation. However, this is not the only reason behind implementing it, there are other key reasons for the benefits of six sigma implementation as follows:-

- ✓ Reduction of defects
- ✓ Reduction of cycle time
- ✓ Reduction of process variability
- ✓ Reduction of customer complaints
- ✓ Reduction of costs
- ✓ Productivity increase
- ✓ Profit increase

- ✓ Improved attitude of top management and employees towards quality and problem solving

## Instructions for participants

This questionnaire is designed according to a strategy and depends on following some instructions, so please read them carefully before answering:

- Please fill the required data according to the order in the questionnaire, i.e. Q1 followed by Q2 and so on.
- Your answers on this questionnaire are not considered as personal information as your name is not required. So we hope that your answers will be truthful, and to the best of your knowledge.
- Please read the questions carefully to understand them before answering them, in order to give the best possible results.
- Please leave the answer blank if you do not know the correct answer.
- You can tick more than one box per question if appropriate.

## Section one: - General information

Please fill in the blanks or tick in a box where it is appropriate for each question below:-

1-Your age in years: Less than 20 <input type="checkbox"/> 20-29 <input type="checkbox"/> 30-39 <input type="checkbox"/> 40-49 <input type="checkbox"/> 50 and over <input type="checkbox"/>
2-Your position in the company: Top manager <input type="checkbox"/> Middle manager <input type="checkbox"/> Supervisor <input type="checkbox"/> Employee <input type="checkbox"/> Other <input type="checkbox"/> please specify.....
3-Your educational level: Less than secondary <input type="checkbox"/> Secondary <input type="checkbox"/> Diploma <input type="checkbox"/> Bachelor degree <input type="checkbox"/> Master degree <input type="checkbox"/> PhD degree <input type="checkbox"/> Other <input type="checkbox"/> please specify.....
4-Experience in years: Less than 5 <input type="checkbox"/> 5-10 <input type="checkbox"/> 11-15 <input type="checkbox"/> 16-20 <input type="checkbox"/> More than 20 <input type="checkbox"/>
5-Please indicate the number of employees in your company Less than 100 <input type="checkbox"/> 100-499 <input type="checkbox"/> 500 and more <input type="checkbox"/>
6-What is the ownership type of your company:-

Public <input type="checkbox"/> Private <input type="checkbox"/> Joint venture <input type="checkbox"/>  Other <input type="checkbox"/> please specify.....
7-What type of industry does your company operate in?  Food industry <input type="checkbox"/> Electrical and Electronics industry <input type="checkbox"/> Mechanical industry <input type="checkbox"/>  Chemical industry <input type="checkbox"/> Textile and Furniture industry <input type="checkbox"/> Building materials industry <input type="checkbox"/>  Other <input type="checkbox"/> please specify..... ..... .....

## Section two: - Quality system and six sigma background

1-What is the current quality system in your company:-  ISO 9001 <input type="checkbox"/> TQM <input type="checkbox"/> Quality control <input type="checkbox"/> Six sigma <input type="checkbox"/> Kaizen <input type="checkbox"/> Lean manufacturing <input type="checkbox"/>  None <input type="checkbox"/> I do not know <input type="checkbox"/> Other <input type="checkbox"/> , please specify.....
2-Did your company previously implement any kind of quality systems? Yes <input type="checkbox"/> No <input type="checkbox"/>  I do not know <input type="checkbox"/> , if yes, what kind of quality system did your company use:-  ISO 9001 <input type="checkbox"/> TQM <input type="checkbox"/> Quality control <input type="checkbox"/> Six sigma <input type="checkbox"/> Kaizen <input type="checkbox"/> Lean manufacturing <input type="checkbox"/>  Other <input type="checkbox"/> , please specify.....
3-Does your company run any kind of quality training for employees?  Yes <input type="checkbox"/> No <input type="checkbox"/> I do not know <input type="checkbox"/>  If yes, what type of quality training is run at your company:-  ISO 9001 <input type="checkbox"/> TQM <input type="checkbox"/> Quality control <input type="checkbox"/> Six sigma <input type="checkbox"/> Kaizen <input type="checkbox"/> Lean manufacturing <input type="checkbox"/>  Other <input type="checkbox"/> , please specify.....

4-If there was a training course designed exclusively for six sigma, would you be interested in taking part in it?    Yes ☐    No ☐    I do not know ☐

5-Do you wish that your company would implement six sigma in the short term?  
Yes ☐    No ☐    I do not know ☐

6-In your opinion, the decision whether or not to introduce six sigma to your company will be taken by:  
Top management☐    Middle management ☐    I do not know ☐  
Other☐ please specify.....  
.....

**Section three:** - In your opinion, what are the factors impeding the adoption of six sigma in your company? Please tick the appropriate choice for each item listed in the following table:-

N	Factors impeding the adoption of six sigma	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1	Lack of top management commitment	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	We have not heard of six sigma and it is unknown to us	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	Lack of knowledge and awareness about six sigma in our company	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4	Lack of six sigma expertise and specialists in our company	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5	six sigma is a complicated technique and we are uncertain about its results and benefits	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6	There is no good communication between all departments in the company	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7	Six sigma is too costly to our company	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8	Lack of financial resources	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9	Lack of six sigma training courses	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

10	Culture effect( resistance to change)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11	Insufficient time for implementation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12	Company's customers are satisfied and happy with the quality of the products	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13	We are happy with the current quality system	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14	Six sigma is not relevant to our work	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15	There is no reason	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Other factors you would like to mention.....

.....

.....

**Section four:** - Please tick the box that best reflects your answer for each factor in the following table:-

1	Factor 1: Top management commitment	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1.1	Top management have a lack of knowledge about six sigma	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.2	Top management do not pay attention to introducing six sigma	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.3	Top management have no clear quality vision	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.4	Top management do not allocate adequate resources and time for quality improvement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.5	There are wrong people in the wrong positions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.6	There is a lack of leadership and effective leaders in your company	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	Factor 2: Training courses	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
2.1	There are no six sigma training	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

	programmes in our company	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.2	There is a lack of six sigma trained professionals in our company	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.3	There is a lack of six sigma training providers in Libya	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.4	In general, there is a lack of quality system training programmes in our company	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.5	There is no training department in your company.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.6	The training managers are not effective and capable	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	Factor 3:Lack of knowledge and awareness about six sigma	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
3.1	Most employees and managers in your company have a lack of knowledge about six sigma	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.2	There is a lack of information and awareness about six sigma in your company	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.3	There is a lack of six sigma conferences, seminars, workshops and publications	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.4	There is a lack of local consultants and expertise in six sigma	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.5	There is a lack of governmental bodies who support , make knowledge and awareness about six sigma	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4	Factor 4: Culture effect ( resistance to change)	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
4.1	In general, there is no desire to change	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.2	The culture of resistance to change is spread throughout the company	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.3	There are difficulties in accepting new techniques & approaches in our company	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.4	There is a lack of knowledge about the advantages and benefits of the new techniques	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.5	People believe that a new technique will threaten their positions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



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## Appendix 10: Research questionnaire in the final study (Arabic version)

السيد المحترم....

بعد التحية...

هذه الاسئلة هي جزء من الدراسة العملية التي اقوم بها الان كطالب دراسات عليا لنيل درجة الدكتوراة من جامعة نورت امبريا – نيوكاسل ببريطانيا.وهي جزء من دراستي تتعلق بتحديد الاسباب والعوائق التي تعيق ادخال و تطبيق نظام 6 سيجما(Six sigma) في الشركات الصناعية في ليبيا. وحيث انه قد تم اختيار مؤسستكم كحالة دراسية لهذا البحث. نأمل تعاونكم ومساهمتكم في تعبئة الاستبيان المرفق. علما بان كل المعلومات التي سيتم تجميعها سوف تستخدم وتحلل اكاديميا لتحقيق الغرض المطلوب من هذا البحث.بالاضافة الى امكانية الاستفادة من النتائج في تطوير وتحسين الجودة في مؤسستكم.

أننا نقدر عاليا تخصيص جزء من وقتكم الثمين بمشاركتكم الفاعلة في الاجابة على هذه الاسئلة وبكل شفافية وشعور بالمسؤولية حيال مؤسستكم والبحث العلمي في آن واحد.



شكرا على حسن اهتمامكم ودعمكم.....والسلام عليكم ورحمة الله وبركاته

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### نبذة بسيطة عن 6 سيجما (Six Sigma)

#### ماهي 6 سيجما (six sigma)?

6 سيجما هي عملية أو إستراتيجية تمكن المنشآت من التحسن بصورة كبيرة فيما يخص عملياتها الأساسية وهيكلها من خلال تصميم ومراقبة أنشطة الأعمال اليومية بحيث يتم تقليل الفاقد واستهلاك المصادر (الوقت – الطاقات الذهنية – الطاقات المادية) وفي نفس الوقت تلبية احتياجات العميل وتحقيق القناعة لديه، ويدل مبدأ 6 سيجما على أن المنشأة تقدم خدمات أو سلعا خالية من العيوب تقريبا لأن نسبة العيوب في 6 سيجما لا يتجاوز 3.4 عيب لكل مليون فرصة، أي أن نسبة كفاءة وفعالية العمليات تصل إلى 99.99966%. وتعتبر 6 سيجما طريقة منضبطة لجمع البيانات، والتحليل الإحصائي لتحديد مصادر الأخطاء وسبل القضاء عليها

خلاصة الأمر أن فكرة 6 سيجما تكمن في أنه إذا كانت المنشأة قادرة على قياس عدد العيوب الموجودة في عملية ما فإنها تستطيع بطريقة علمية أن تزيل تلك العيوب وتقترب من نقطة خلو من العيوب.

#### مزايا 6 سيجما:- (six sigma)

- المساعدة في فهم وإدارة احتياجات العملاء.
- التقليل من شكاوي العملاء وتحقيق أقصى قدر من رضاهم.
- اعتماد الدقة في تحليل البيانات للحد من الخلل في العملية.
- التطور السريع ومواصلة تحسين لعملية الإدارة.
- التقليل من التكاليف اللازمة لاجراء العمليات.
- الحد من التغييرات والتقلبات في العمليات وبالتالي التقليل من العيوب والاختفاء.
- رفع معدلات الكفاءة بين الموظفين.
- التدريب جزء لا يتجزأ من نظام الإدارة.
- الترتيب والتنظيم عملية أساسية لتحقيق المتطلبات اللازمة

#### تعليمات للمشاركين

- صُمِّمَ هذا الاستبيان وفقاً لمخطط يعتمد على تتبع التعليمات التالية، لذا يُرجى التمعن في قراءتها قبل الإجابة:
- الرجاء ملأ البيانات المطلوبة حسب ترتيبها في نموذج الاستبيان، مثال: سؤال 1 يتبعه سؤال 2.
  - إن إجاباتك في هذا النموذج ليست معلومات خاصة أو شخصية بما أنه لم يُطلب منك وضع اسمك، لذلك نأمل أن تكون إجاباتك حقيقية وبأتم المعرفة.
  - يرجى قراءة الأسئلة بتمعن لفهمها قبل الإجابة عليها من أجل الحصول على أفضل النتائج الممكنة.
  - يرجى ترك الإجابة فارغة إذا لم تعرف الإجابة الصحيحة.
  - يمكنك اختيار أكثر من إجابة في بعض الأسئلة إن استوجب الأمر.

#### الجزء الأول: معلومات عامة

يرجى ملأ الفراغات أو وضع علامة في المربعات ☐ أمام الإجابة المناسبة لكل سؤال:-

1- كم عمرك بالسنوات:				
<input type="checkbox"/> أقل من 20	<input type="checkbox"/> 20-29	<input type="checkbox"/> 30-39	<input type="checkbox"/> 40-49	<input type="checkbox"/> 50 فأكثر
2- وظيفتك في الشركة:				
<input type="checkbox"/> مدير عام	<input type="checkbox"/> مدير ادارة وسطى	<input type="checkbox"/> مشرف	<input type="checkbox"/> موظف	
<input type="checkbox"/> أخرى الرجاء ذكرها .....				
3- المستوى الدراسي:				

<input type="checkbox"/> دون الثانوية <input type="checkbox"/> ثانوية <input type="checkbox"/> دبلوم <input type="checkbox"/> بكالوريوس <input type="checkbox"/> ماجستير <input type="checkbox"/> دكتوراه <input type="checkbox"/> أخرى الرجاء ذكرها.....
<b>4- سنوات الخبرة:</b> <input type="checkbox"/> أقل من 5 سنوات <input type="checkbox"/> 10-5 <input type="checkbox"/> 15-11 <input type="checkbox"/> 20-16 <input type="checkbox"/> أكثر من 20 سنة
<b>5- يرجى ذكر عدد الموظفين بالشركة/مكان عملك:</b> <input type="checkbox"/> أقل من 100 <input type="checkbox"/> 499-400 <input type="checkbox"/> أكثر من 500
<b>6- ما هي صفة ملكية الشركة/مكان عملك:</b> <input type="checkbox"/> عامة <input type="checkbox"/> خاصة <input checked="" type="checkbox"/> مشتركة <input type="checkbox"/> أخرى الرجاء ذكرها.....
<b>7- ما هو المجال الصناعي الذي تشتغل فيه الشركة/مكان عملك؟</b> <input type="checkbox"/> الصناعات الغذائية <input type="checkbox"/> الصناعات الكهربية والإلكترونية <input type="checkbox"/> الصناعات الميكانيكية <input type="checkbox"/> الصناعات الكيماوية <input type="checkbox"/> صناعة النسيج والأثاث <input type="checkbox"/> مواد البناء <input type="checkbox"/> أخرى الرجاء ذكرها.....

**الجزء الثاني:- نظام الجودة وخلفية عن 6 سيجما :**

<b>1- ما هو نظام الجودة الحالي بالشركة/مكان عملك:</b> <input type="checkbox"/> أيزو 9001 <input type="checkbox"/> TQM <input type="checkbox"/> مراقبة جودة <input type="checkbox"/> 6 سيجما <input type="checkbox"/> Kaizen <input type="checkbox"/> Lean Manufacturing <input type="checkbox"/> لا أعلم <input type="checkbox"/> لا يوجد <input type="checkbox"/> أخرى الرجاء ذكرها.....
<b>2- هل سبق لشركتكم في الماضي ان طبقت أي نوع من أنظمة الجودة؟</b> <input type="checkbox"/> نعم <input type="checkbox"/> لا <input type="checkbox"/> لا أعلم إذا كانت الاجابة نعم، أي نوع من أنظمة الجودة التي استعملتها الشركة/مكان عملك:- <input type="checkbox"/> أيزو 9001 <input type="checkbox"/> TQM <input type="checkbox"/> مراقبة جودة <input type="checkbox"/> 6 سيجما <input type="checkbox"/> Kaizen <input type="checkbox"/> Lean Manufacturing <input type="checkbox"/> أخرى الرجاء ذكرها.....
<b>3- هل تقوم شركتكم بأجراء دورات تدريبية على اي نوع من أنظمة الجودة لفائدة العاملين؟</b> <input type="checkbox"/> نعم <input type="checkbox"/> لا <input type="checkbox"/> لا أعلم إذا كانت الاجابة نعم، على اي نوع من أنظمة الجودة يجري التدريب:- <input type="checkbox"/> أيزو 9001 <input type="checkbox"/> TQM <input type="checkbox"/> مراقبة جودة <input type="checkbox"/> 6 سيجما <input type="checkbox"/> Kaizen <input type="checkbox"/> Lean Manufacturing <input type="checkbox"/> لا يوجد <input type="checkbox"/> أخرى الرجاء ذكرها.....
<b>4- إذا كانت هناك دورة تدريبية مصممة لـ 6 سيجما ، هل لديك الرغبة بالمشاركة فيها؟</b> <input type="checkbox"/> نعم <input type="checkbox"/> لا <input type="checkbox"/> لا أعلم
<b>5- هل تتمنى ان تقوم شركتكم بتطبيق 6 سيجما في أقرب وقت؟</b> <input type="checkbox"/> نعم <input type="checkbox"/> لا <input type="checkbox"/> لا أعلم
<b>6- حسب رأيك، من سيتخذ قرار إدخال أو عدم إدخال 6 سيجما إلى الشركة/مكان عملك:</b>

الإدارة العليا <input type="checkbox"/>	الإدارة الوسطى <input type="checkbox"/>	لا أعلم <input type="checkbox"/>
أخرى <input type="checkbox"/> الرجاء ذكرها .....		

الجزء الثالث: - حسب رأيك ما هي العوامل التي تعيق تبني أو تطبيق 6 سيجما بالشركة/مكان عملك ؟ يرجى وضع علامة أمام الاختيار المناسب لكل بند مذكور في الجدول التالي:-

رقم	العوامل التي تعيق تبني أو تطبيق 6 سيجما	رفض بقوة	رفض	حياد	موافق	موافق بقوة
1	عدم التزام الإدارة العليا بالشركة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	لم نسمع بـ 6 سيجما من قبل وهي غير معروفة عندنا	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	نقص المعرفة والتوعية بـ 6 سيجما في الشركة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4	عدم وجود خبراء ومختصين بـ 6 سيجما بالشركة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5	6 سيجما تقنية معقدة، ونحن غير متأكدين من نتائجها ومنافعها	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6	لا يوجد تواصل جيد بين إدارات وأقسام الشركة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7	6 سيجما مكلفة جدا للشركة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8	نقص الموارد المالية للشركة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9	عدم وجود دورات تدريبية خاصة بـ 6 سيجما	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10	تأثير الثقافة (مقاومة التغيير)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11	لا يوجد لدينا الوقت الكافي لتطبيق 6 سيجما	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12	زبائن الشركة راضون وسعداء بجودة المنتجات	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13	نحن سعداء بنظام الجودة الحالي	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14	6 سيجما ليست ذات صلة بعملنا	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15	لا يوجد أي سبب	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

عوامل أخرى ترغب في ذكرها.....

الجزء الرابع:- يرجى وضع علامة أمام المربع الذي يعكس جيدا إجابتك لكل عامل في الجدول التالي:-

1	العامل 1: التزام الإدارة العليا	رفض	رفض	حياد	موافق	موافق
---	---------------------------------	-----	-----	------	-------	-------

		بقوة			بقوة	
1.1	نقص المعرفة لدى الإدارة العليا بـ 6 سيجما	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.1	الإدارة العليا لا تهتم بإدخال 6 سيجما	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.1	الإدارة العليا لا تمتلك رؤية واضحة حول الجودة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.1	الإدارة العليا لا تخصص موارد ووقت كافٍ لتحسين الجودة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5.1	وجود أشخاص غير مناسبين في مناصب غير مناسبة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6.1	نقص الروح القيادية والقادة الأكفاء في الشركة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	العامل 2: الدورات التدريبية	موافق بقوة	موافق	حياد	رفض	رفض بقوة
1.2	لا توجد برامج تدريب على 6 سيجما في الشركة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.2	عدم وجود موظفين مهنيين مدربين على 6 سيجما في الشركة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.2	عدم وجود شركات مختصة تقوم بالتدريب على 6 سيجما في ليبيا	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.2	عموما... عدم وجود برامج تدريب على أنظمة الجودة في الشركة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5.2	لا توجد إدارة تدريب في الشركة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6.2	مدراء التدريب في الشركة غير أكفاء أو قادرين	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	العامل 3: عدم المعرفة والتوعية بـ 6 سيجما في الشركة	موافق بقوة	موافق	حياد	رفض	رفض بقوة
1.3	أغلب المدراء والموظفين بالشركة تنقص لديهم المعرفة بـ 6 سيجما	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.3	عدم وجود معلومات وتوعية حول 6 سيجما بالشركة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.3	عدم وجود منتديات ومؤتمرات وورش عمل ومنتشورات حول 6 سيجما	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.3	عدم وجود مستشارين وخبراء 6 سيجما محليين	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5.3	عدم وجود هيئات حكومية تدعم وتقوم بالتعريف والتوعية بـ 6 سيجما	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4	العامل 4: تأثير الثقافة (مقاومة التغيير)	موافق بقوة	موافق	حياد	رفض	رفض بقوة
1.4	لا توجد رغبة في التغيير بالشركة بصفة عامة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.4	ثقافة مقاومة التغيير منتشرة في الشركة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.4	توجد صعوبات في قبول تقنيات وأنظمة جديدة في الشركة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.4	عدم وجود معرفة حول مزايا ومنافع التقنيات الجديدة	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5.4	يعتقد الناس أن التقنية الجديدة سوف تهدد مناصبهم	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



## Appendix 11: Supervisor's support letter



**To whom it may concern**

This is to confirm that Mr Osama Elgadi is registered as a fulltime PhD research student at Northumbria University, Mechanical Engineering department in Newcastle, UK.

I am currently principal supervisor for Mr Elgadi's Research into the use of Six Sigma in Libyan Manufacturing companies. I strongly believe that this work could be of significant importance to your company in terms of improving the product and service quality and increasing the efficiency of the manufacturing industry.

In order to establish the current level of quality management and the barriers to the implementation of Six Sigma it is essential that Osama conducts his survey with your company to collect the relevant data. Therefore, I would be extremely grateful if you would offer him assistance in this regard.

Thank you in advance for your cooperation

Best Regards

A handwritten signature in blue ink that reads "M. Birkett".

**Dr Martin Birkett**

*Senior Lecturer*

*Programme Leader MEng/BEng(Hons) Mechanical Engineering*

*Department of Mechanical & Construction Engineering.*

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## **Appendix 12: Research questionnaire covering letter**

**Dear participant**

I'm a PhD student in the Faculty of Engineering and Environment at Northumbria University in Newcastle, UK. One of my research objectives is to identify the reasons and barriers behind the lack of six sigma use in Libyan manufacturing companies.

I have selected your company as a part of my research, so your participation is very important in order to achieve my goal. This questionnaire is completely anonymous and your identity will not be marked on it. The data gathered for this research will be for the purpose of my academic studies only. Also the results of my studies might be useful for your company.

I would be very grateful if you could spare some time to complete this questionnaire

Thank you very much for taking part in this research

**Osama Elgadi**

**Mobile number: 00447459356974**

**Email: [osyma75@yahoo.com](mailto:osyma75@yahoo.com)**

**[osama.elgadi@northumbria.ac.uk](mailto:osama.elgadi@northumbria.ac.uk)**



## **Appendix 13:Framework assessment covering letter**

**Dear Sir/ Madam**

Following to our previous interview and questionnaire regarding six sigma barriers in Libyan manufacturing companies, I have now developed a six sigma implementation framework for LMCs. As you have a background about my research, could you please review the framework and give me your opinion and comments. I would be grateful if you can complete it within three weeks and I will give you a follow up by telephone to discuss this further.

Please find attached:

- The six sigma implementation framework
- Acceptance form

Thank you again for taking part in this research

Osama Elgadi

Mobile number: 00447459356974

Email: osyma75@yahoo.com

osama.elgadi@northumbria.ac.uk

## Appendix 14: Framework acceptance form

### Acceptance form

Six sigma implementation framework for Libyan manufacturing companies

After reviewing the framework, I would :

1- Accept the framework in its current status with no comments ☐

2- Accept the framework with comments ☐

Please mention your comments below

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3- Reject the framework due to some reasons ☐

Please mention your reasons below

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